the Petroleum Engineer

...ds for Operating Men

NOVEMBER • 1947

VOLUME XIX NUMBER 2

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Dec. 1-5—ASME, annual meeting, Chalfonte and Haddon Hall, Atlantic City, N. J.

Dec. 1-6—Chemical Institute Exposition, Grand Central Palace, New York.

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Dec. 4-6—Interstate Oil Compact, quarterly meeting, Oklahoma City.

Dec. 6—Nomads, Christmas party, Louis Sherry, New York City.

Dec. 8—Nomads, monthly meeting, Ye Olde College Inn, Houston, Texas.

Dec. 10—Nomads, monthly meeting, Jonathan Club, Los Angeles, Calif.

Dec. 11—Mid-Continent Oil & Gas Assn, La.-Ark. division, Roosevelt Hotel, New Orleans, La.

Jan. 12-16, 1948—SAE, annual meeting, Book Cadillac Hotel, Detroit, Mich.

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Jan. 14-15—AAPG, regional meeting, Jefferson Hotel, St. Louis, Mo.

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Mar. 24-26—Southern Gas Assn, annual meeting, Galveston, Texas.

Mar. 24-26—API, Mid-Continent district, production, Broadview Hotel, Wichita, Kans.

Apr. 5-7—Western Petroleum Refiners Assn, annual meeting, Galvez and Buccaneer Hotels, Galveston, Texas.

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Apr. 14-15—API, Southwestern production division, Plaza Hotel, San Antonio, Texas.

Apr. 19-21—American Society of Lubricating Engineers, annual convention, Statler Hotel, Buffalo, N. Y.

Apr. 21-23—National Petroleum Assn, Hotel Cleveland, Cleveland, Ohio.

Apr. 26-29—Am. Assn of Petroleum Geologists, Soc. of Economic Paleontologists & Mineralologists, & Soc. of Exploration Geophysicists, annual meeting, Denver, Colo.

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The course of OIL

FOSTER TIDELANDS DEVELOPMENT

If members of Congress are confronted with a bill to convey to the states all rights and interests in the tidelands of the U. S. except the oil, gas, and other mineral rights, they may pass it unless the results of such action are forcefully depicted.

In the U. S. oil industry, the advantages of the free, competitive atmosphere in which it has prospered are so clear and simple that its members are only now beginning to understand that not every one sees the same picture. Now the encroachment of Federal control appears imminent and the danger is not comprehended by the general public.

Suppose the Congress passes a bill to relinquish all rights in the tidelands except petroleum and mineral rights. The objective will be to preserve the oil and gas underneath the ocean beds for supply in time of need. This sounds reasonable to those who fear for our oil supplies in the event of another war. It probably sounds like a perfect solution to those who know nothing of oil development.

Can we explain to these well-intentioned people that such a move on the part of Congress would have exactly the opposite effect to the one they seek? Leaving out the arguments of states rights and Federal responsibilities, which are subordinate to the will of the people in our republic as it now stands, let us take a look at possible results.

In the first place no government has ever successfully developed oil resources. Take our own country where the government owns one-fifth of the land. With all the speeded-up development possible after the last war began the government's contribution to oil supply was negligible.

In a plea for Russia's need of oil (pure assumption) in the *New Republic* (Henry Wallace, editor) this statement is made: "The principal reason for cheap, plentiful petroleum products in the United States is that North America has been richly blessed with oil resources." The article also states that in proved oil resources Russia is a starveling.

It is true that the U. S. has rich oil resources and it is true that Russia, with potential oil areas two and one-half or three times that of the U. S., has not developed its resources to any extent. The difference has been in the dynamics of free enterprise and the static quality of government control.

There are other examples of the inadequacy of government-controlled exploration and production of oil. It must mean something that Great Britain and the United States, the two leading democracies, control almost 90 per cent of the world's production.

To accuse the Federal government of inconsistency may seem unnecessary, but we wish to point out one inconsistency that has not been evident from general reports. The primary argument for pushing through a bill holding oil and mineral rights to the tidelands under Federal ownership is the danger of a war with Russia when military demand for oil supplies would be tremendous. Tidelands oil is to be saved for such an emergency. On the other hand, Federal authorities ignore this plan by contriving at development of Middle East oil resources at the expense of domestic development. In the event of this speculative war, who would benefit by Middle East oil? We, of the United States across the Atlantic and the Mediterranean or around the Horn? Or Russia with a land border on the south?

Geologists believe the tidelands to be rich, some going so far as to predict they may hold as great a reservoir as the land area of the United States, but development of these marginal areas will be highly specialized and very costly. No oil company that risks its capital for profit can afford to stake it on a Federal lease when development may be delayed or stopped to fit a government policy of shutting-in for political emergency. Some companies with leases in the Gulf of Mexico have already slowed or halted activities because of the Supreme Court Tidelands decision.

What most people do not understand is that development of oil and gas resources is slow and gradual. To reach its zenith, a field may require years of study and drilling, innovation of methods and invention of tools. Even fabulous East Texas was not born in a day or a year. Discovered in 1930, it wasn't until war times that its extent began to be realized. No man can estimate the time it will take to develop the tidelands. Here we have a special situation, ventured into only because of the experience gained in an eagerly competitive enterprise where men will spare no effort and try anything that shows promise of uncovering new oil reserves, for only the hope of profit—the most effective (and least expensive) reward any nation can bestow.

The soundest course for the welfare of the U. S. is to hold to the tried principle of private development of the oil resources of our land. In two world wars the U. S. oil industry has provided the fuel of victory. To run the risk of an untried plan on the chance of ample provision for emergencies is dangerous. If our world political organization fails to avert a third world war we should be safely backed by the initiative, experience, and power generated by 13,000 oil-producing companies.—E. A.

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SELECT CEMENT TO FIT THE JOB

SCANNING WASHINGTON'S OIL HORIZON

By MILBURN PETTY

WASHINGTON—Danger signals for the petroleum industry are flying on Pennsylvania Avenue from the White House to the Capitol with the threat of federal regulation hinging largely on the winter weather ahead.

The threat stems from the impending fuel oil shortage with demand forecast at 20 per cent above last year and stock build-up making little headway despite record high refinery runs.

A cold winter would ripen proposals for federal oil control. Let the public become convinced that the industry cannot supply them with fuel oil and they will demand that the government take over. So far, the public is unshaken in its confidence that the industry can meet all demands as it has always done.

But there is a "political climate" developing here that could be dangerous to the industry's continued operation as a free enterprise *if* any considerable number of homes go without fuel oil this winter. A number of factors contribute to this situation. Some involve only a few companies, others more. But they are all charged up against the word—Oil.

For example, Senator Brewster's attack on what he calls "price gouging" in the sale of Middle East oil to the Navy involves only two companies; his charges of a cartel in that area include several more. The circle is widened when independent producers charge that foreign oil operations are monopolized by a half dozen companies. More of the major companies are included in the Department of Justice's move toward pipe line divorcement. Independent refiners are drawn in when the Federal Trade Commission reveals that it is investigating basing point pricing in oil.

There is tension within the industry, too. Domestic producers are bitter over steel being exported for the Arabian pipe line while many operators are unable to obtain tubular goods for offset wells. Some independent refiners are complaining that their crude sources are being dried up. Many marketers contend they are not getting their fair share of supplies available and some are openly advocating a government-supervised allocation system.

All of these factors serve to keep oil in the newspaper headlines—unfavorably, most of the times.

Senator Wherry and his Senate Small Business Committee have taken up the cudgel for many of the independents complaining. His report will have blistering criticism for the practices of some companies and probably will recommend remedial measures.

It is important to remember that Wherry is not a New Dealer but one of the three top Republicans in the Senate. Brewster of Maine is usually regarded as a conservative even among the Republicans (some of his brethren are as wild-haired as any radical follower of FDR). Oil, as stated in this column previously, has as much—if not more—to fear from the Republicans as from the Democrats. It was the consumer states that gave the Republicans a majority in Congress. The oil state members are mostly Democrats. And 1948 is a presidential election year with no holds barred in the political fight for the pivotal states—the consuming areas.

So, oil men would do well not to count on the Republicans in Congress to kill off whatever program the Truman Administration devises for allocating supplies and controlling prices of scarce commodities. Of course, Truman's program "to soften the impact of foreign aid" will not be accepted by the Republicans without many changes. But the residue may be more akin to wartime controls than oil men, generally, would desire.

This line of argument is being urged by some leading oil men who contend that the industry should not be caught without a program of its own, should the fuel oil situation become as critical as some industry authorities now expect.

Even if there should be ample supply with enough transportation, it would be too much to hope that it would be evenly distributed among all suppliers in accordance with demands upon them, they contend. Only possible way out, they argue, is an industry-wide program for cooperation among suppliers, which would require antitrust law clearance. It has been suggested that the industry, through the National Petroleum Council, should take steps now to obtain such clearance and have the plans worked out on paper, at least, in case the situation requires concerted action.

●

More certain than the oil shortage with prospective government action, however, is the threat embodied in proposed legislation now being drafted by the Truman Administration to implement the Supreme Court's decree in the California Tidelands Case. The decree, as entered, declares California has no title or property interest in these offshore submerged lands and gives the federal government full power and dominion (but not proprietorship rights) over these lands.

This puts it up to Congress to decide how offshore submerged lands, generally, should be administered. To offset any quit-claim move by the states, the government may renounce all claims except as to mineral rights. One idea among the military is that the entire coastline should be surveyed for the most promising areas, then designate them as government oil reserves wherein development would be strictly controlled and production held back for periods of tight supply.

The West Coast stands to lose more oil lands if Interior Secretary Krug accedes to Navy's suggestion that the Elk Hills Naval Petroleum Reserve be enlarged by inclusion of an additional 7000 acres, mostly to the South and West around a new 2000-barrel well brought in within the reserve.

●

Meanwhile, there is new evidence of a philosophy within the Truman Administration favoring a cut-back in domestic production and greater use of foreign oil, as was discussed in this space last month.

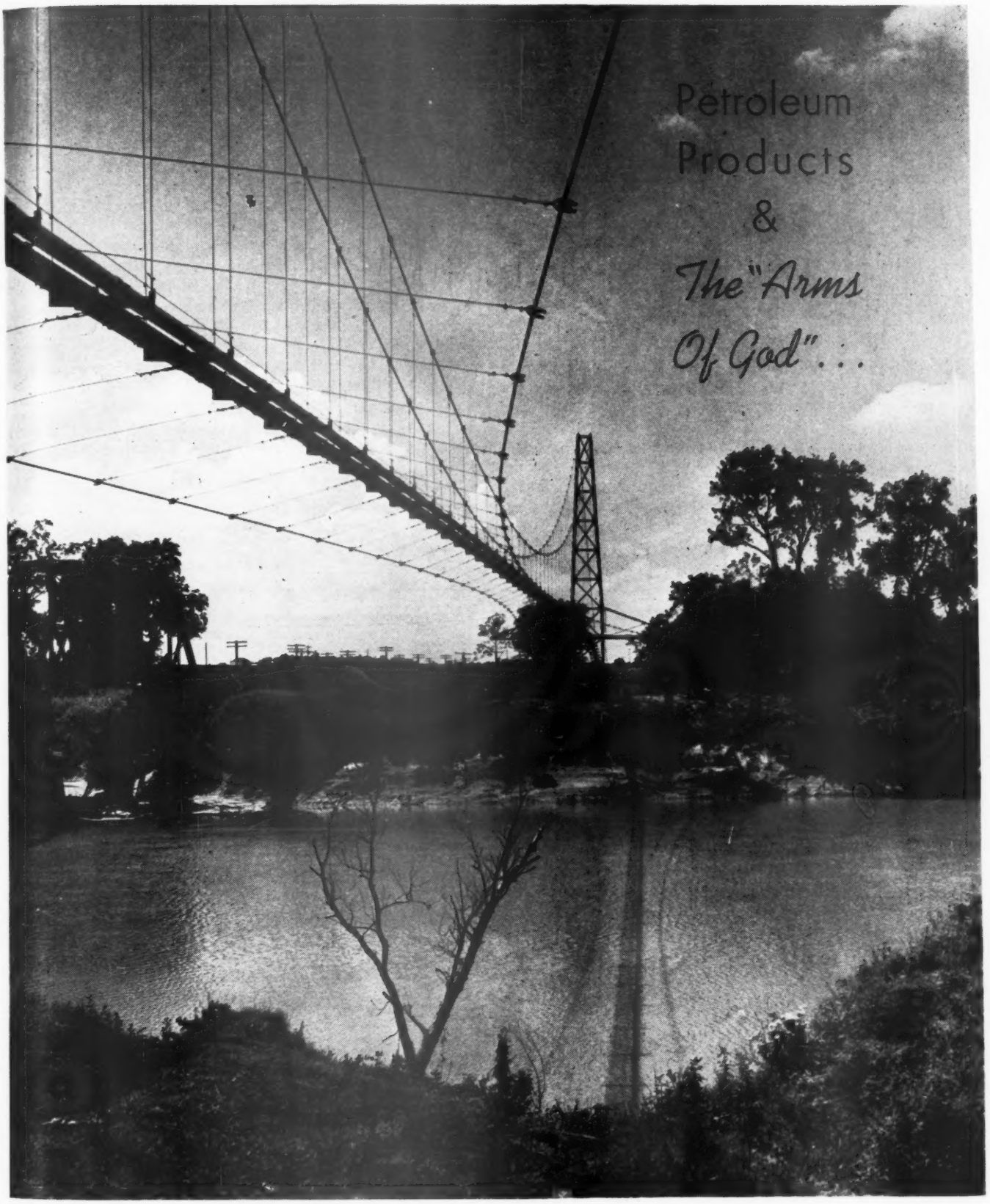
Secretary Krug's report on the Marshall Plan hinted at this idea and promptly drew fire from Russell Brown, general counsel for the Independent Petroleum Association of America. Krug's statements, said Brown, indicate "a mental attitude which, if accepted, would destroy the domestic oil industry of the United States and leave to the uncertainty of unstable foreign friendships, interruptable transportation systems, and a few cartel-bound corporations the economic life and military safety of the United States."

The latest statement of the shut-in policy comes from Undersecretary of Navy Kenney. Defending the approval of pipe exports for the Arabian line, Kenney told Senator Wherry's committee:

"At the present time, it would seem that the best and certainly the cheapest way of assuring to this country the greatest possible fund of domestic proved reserves during war would be to relieve the drain upon our resources during peacetime by relying heavily on imported petroleum.

"Every barrel of Middle Eastern oil used is a barrel of oil saved for this country.

"Furthermore, with an estimated demand in 1949 of 10,000,000 barrels per day (against current production slightly in excess of 8,300,000 barrels per day) it is imperative that Middle Eastern oil—the largest known source of petroleum—be utilized to the fullest extent as soon as possible."



Legend says Spaniards fleeing Indians in Texas long ago were saved when a sudden flood in a stream they had just crossed stopped the savages. Thankfully, they named the protecting river the "Arms of God," in Spanish, "Brazos del Dios," now shortened to Brazos. Modern Brazos floods seem heedless of whose path they block, but flow of petroleum products in the 8-inch line above will never the interrupted. Brown & Root, Inc. have bridged the Brazos near Sealy with a 625-foot (between towers) pipe line crossing of their design, fabrication and erection. Take your river problems to Brown & Root, Inc.

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national petroleum situation

By H. J. STRUTH,*
Petroleum Economist

PROFITS VS. REPLACEMENT. Profits of oil companies are large. They invite criticism of legislators, tax collectors, the man on the street. What perhaps is not generally realized is that today's profits come from oil reserves found 10 or 15 years ago, when exploration and finding costs were far below today's replacement costs. A large share of oil profits must perforce be reinvested in the search for new reserves. Facts show that it takes six dollars to replace oil today that cost one dollar in pre-war days. Oil profits, therefore, are not as glamorous as they may seem.

*Editor, *THE PETROLEUM DATA BOOK*

PRICE RELATIVITY. Crude price advances averaged 20 cents per barrel throughout Mid-Continent area; national average increase including advances in California and Michigan is about 17 cents. National average price is now $2.11 per bbl, which represents an index relative to 1926 of 112. Wholesale price index of all commodities now stands at 158. If crude prices had advanced like all other commodities, average price would now be $2.97 instead of $2.11.

IMPROVED STOCK PICTURE. Stocks of crude and refined products in the U. S. are within 1 per cent of normal economic level. Crude stocks are 1 per cent above last year, while refined products stocks are only about 2 per cent below last year. While the overall picture is highly favorable, the distribution of such stocks is decidedly unfavorable. Movement of certain grades of crude oil and distillate fuel oils to centers experiencing shortages is chief difficulty. While mild October effected some improvement in distillate picture, outlook still calls for drastic action to prevent distillate fuel shortages in the Northeast and Great Lakes areas.

EXPLORATION STIMULUS. Rising oil prices have completely changed the exploration and drilling outlook. Wildcat operations are 13 per cent above last year and some states, notably Arkansas, Oklahoma, California, Kansas and Mississippi, have chalked up gains ranging from 33 per cent to 76 per cent. Oil well completions are up nearly 20 per cent over last year, while gas well completions have increased 10 per cent. Only lack of equipment has prevented an even more pronounced gain in drilling operations.

Comparative Statistics, October, 1947

*All figures are computed on a Bureau of Mines' Basis**

	October 1947(p)	Sept. 1947(p)	October 1946	This year to date	Last year to date	Per cent change
Wells drilling	4,400	¶4,450	4,075	4,400	4,075	+ 8
Total wells drilled§	3,249	3,171	2,693	28,074	24,476	+15
Development wells	2,760	2,693	2,269	23,871	20,753	+15
Oil	1,693	1,636	1,320	14,700	12,306	+20
Gas	317	304	295	2,751	2,510	+10
Dry§	750	753	654	6,420	5,937	+ 8
Per cent dry	27.2	28.0	28.8	26.9	28.6	— 1.7
Wildcat wells	489	478	424	4,203	3,723	+13
Oil	72	84	74	645	546	+18
Gas	22	23	12	182	107	+70
Dry	395	371	338	3,376	3,070	+10
Per cent dry	80.8	77.6	79.7	80.3	82.5	— 2.2
Crude supply*	171,800	164,200	155,324	1,610,098	1,514,432	+ 6
Daily average	5,542	5,473	5,010	5,296	4,982	
Crude demand‡	172,200	167,000	155,482	1,609,631	1,510,031	+ 7
Daily average	5,555	5,567	5,015	5,295	4,967	
Crude stocks	230,600	231,000	227,660	230,600	227,660	+ 1
Days supply	42	41	45	42	45	
Natural gasoline production	11,200	10,800	10,125	107,111	94,647	+13
Daily average	361	360	327	352	311	
Motor fuel production	75,000	72,470	67,305	691,555	640,954	+ 8
Daily average	2,419	2,416	2,171	2,275	2,108	
Gasoline yield, per cent	40.7	40.5	40.6	40.1	39.2	+ 0.9
Motor fuel demand‡	75,400	73,830	69,273	700,826	650,696	+ 8
Daily average	2,432	2,461	2,235	2,305	2,140	
Motor fuel stocks^	80,450	¶80,850	83,940	80,450	83,940	— 4
Days supply	33	33	38	33	38	
Fuel oil production	67,000	64,000	58,209	622,304	601,597	+ 3
Daily average	2,161	2,133	1,878	2,047	1,979	
Fuel oil demand‡	68,200	60,060	56,984	680,296	610,570	+11
Daily average	2,200	2,002	1,838	2,238	2,008	
Fuel oil stocks	115,800	¶113,500	123,450	115,800	123,450	— 6
Days supply	53	57	67	53	67	
Refinery still runs	163,300	158,750	146,816	1,527,094	1,441,512	+ 6
Daily average	5,268	5,292	4,736	5,023	4,742	
All refined stocks	287,300	¶284,600	294,261	287,300	294,261	— 2
Days supply	50	52	57	50	57	

*Unless otherwise stated all figures represent thousands of barrels. ***Does not include input wells. (p) Preliminary. *Includes domestic production and imports.
‡Total demand, including exports. **Price 1926 (Index 100). ^Includes finished and natural gasoline. §Includes service wells. †All Commodity Index: 158. ¶Revised.

Preliminary estimates based upon data furnished by American Petroleum Institute, U. S. Bureau of Mines, State Agencies, and other official sources.

Economic Position of U. S. Petroleum Industry

Ten Months Ending October 31, 1947

	Normal	Actual	Per cent of normal
Drilling*** (wells completed)	25,840	26,250	102
Production (daily crude output)	5,075	5,032	99
Refining (daily still runs)	5,065	5,023	99
Stocks (crude and refined)	524,000	517,900	99
Price of crude (per bbl)	$1.88**	$2.11	112†

Current Crude Oil Prices

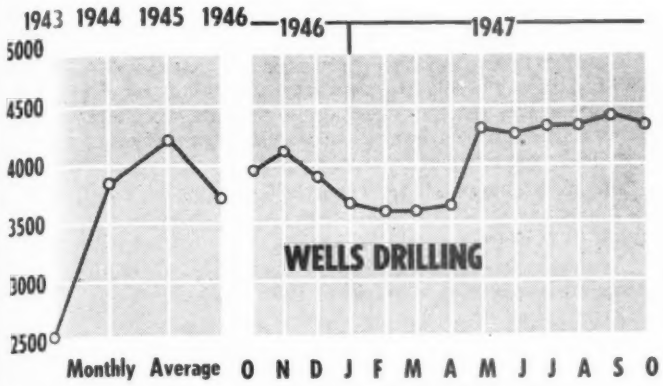
U. S. average	$2.11	Louisiana	$2.12
Texas	2.11	Arkansas	1.93
California	1.92	New Mexico	1.90
Oklahoma	2.13	Mississippi	1.92
Kansas	2.12	Illinois	2.26
		Other states	2.65

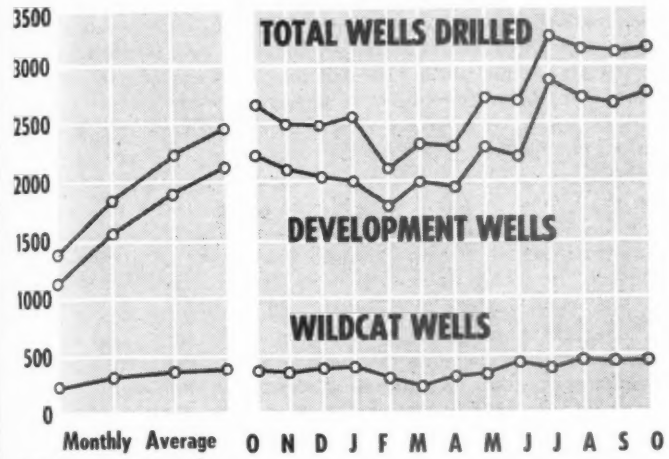
Basic crude prices:

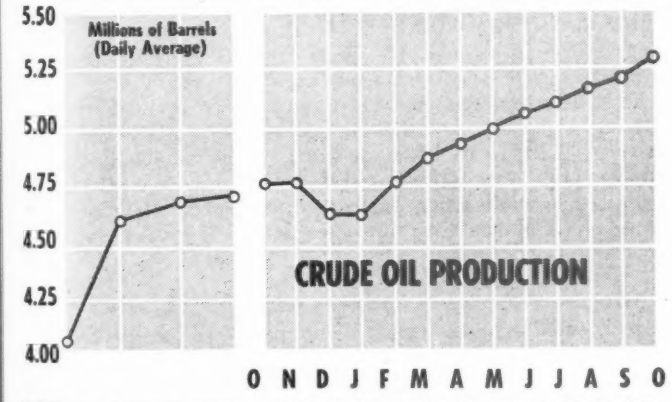
Oklahoma-Kansas (36 gr.)	$2.07
Texas Gulf Coast (36 gr.)	2.30
East Texas	2.15
West Texas (36 gr.)	1.94
California Signal Hill (26 gr.)	1.91
Pennsylvania, Bradford	4.50

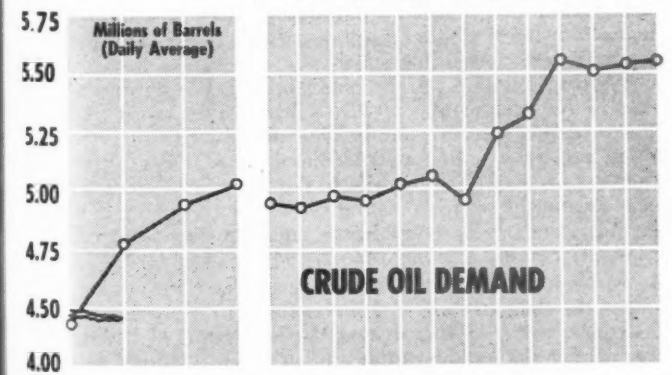
Drilling and Production Statistics by States

	October 1947(p)	Sept. 1947(p)	October 1946	This year to date	Last year to date	Per cent change
Total wells drilled§	3,249	3,171	2,693	28,074	24,476	+ 15
Texas	835	869	635	7,901	6,608	+ 20
California	211	168	145	1,688	1,487	+ 14
Oklahoma	346	380	251	3,528	2,412	+ 46
Kansas	294	230	170	2,245	1,665	+ 35
Louisiana	189	157	144	1,348	1,154	+ 17
Arkansas	45	38	15	275	152	+ 81
New Mexico	44	58	46	462	333	+ 39
Mississippi	48	35	23	416	198	+110
Illinois	200	200	228	1,721	1,978	— 13
Other states	1,037	1,036	936	8,490	8,489	0
Wildcats drilled	489	478	424	4,203	3,723	+ 13
Texas	180	155	148	1,510	1,398	+ 8
California	34	28	29	288	203	+ 42
Oklahoma	75	91	67	709	421	+ 68
Kansas	40	37	16	336	239	+ 41
Louisiana	25	26	20	236	210	+ 12
Arkansas	9	9	3	58	33	+ 76
New Mexico	5	6	4	40	38	+ 5
Mississippi	9	11	4	80	60	+ 33
Illinois	34	41	71	350	503	— 30
Other states	78	74	62	596	618	— 4
Daily crude production	5,289	5,213	4,785	5,032	4,744	+ 6
Texas	2,387	2,340	2,072	2,220	2,086	+ 6
California	916	916	866	909	861	+ 6
Oklahoma	398	397	358	382	371	+ 3
Kansas	298	302	278	288	265	+ 9
Louisiana	457	445	410	433	388	+ 12
Arkansas	83	82	79	81	77	+ 5
New Mexico	121	119	104	110	101	+ 9
Mississippi	104	102	76	93	63	+ 48
Illinois	174	170	211	181	208	— 13
Other states	351	340	331	335	324	+ 3

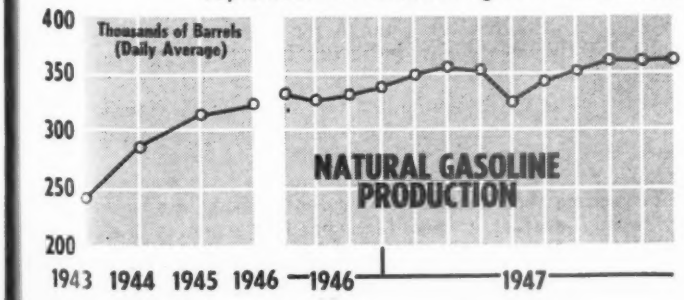


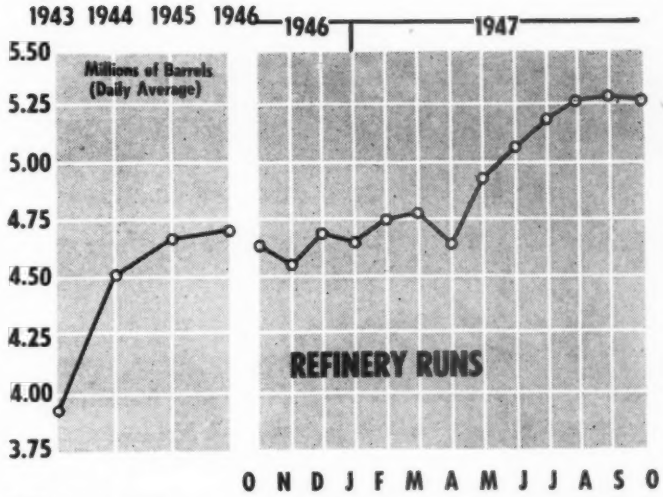


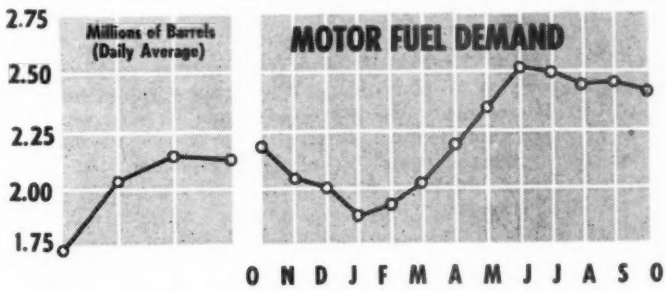


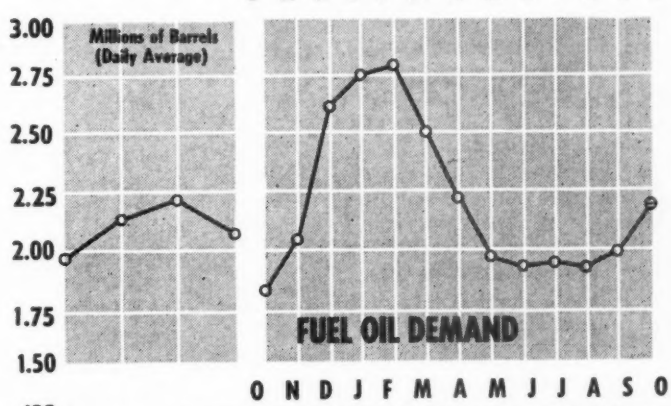


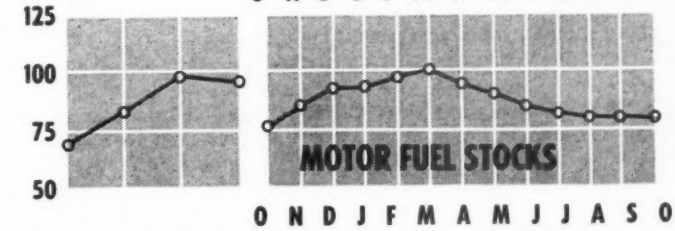
September and October figures are estimates.

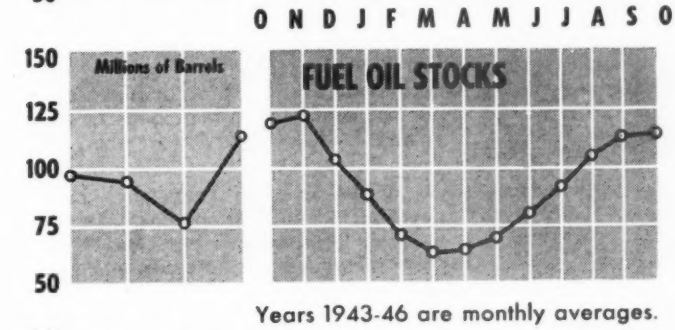




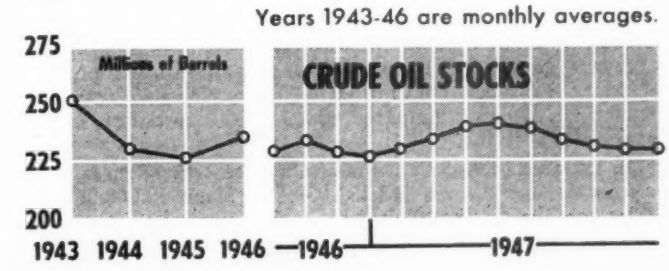




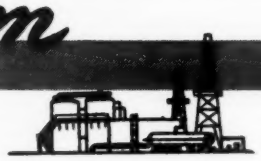




Years 1943-46 are monthly averages.



highlights in oildom



● **PETROLEUM SUPPLY INCREASING.** Ability of the petroleum industry to supply substantially larger volumes of crude and products to meet current pressing demands is encouraging and an outstanding feature of the situation in recent weeks, the supply and demand committee of the Independent Petroleum Association has informed the Interstate Oil Compact Commission in its November report.

Increased levels of operation by the industry to meet the continued larger demands for oil products, with national output of both crude petroleum and refined products rising sharply, has been in keeping with gasoline consumption remaining close to the summer peak and the trend of oil demands turning upward in response to seasonal factors, the committee wrote.

During the last two months, United States production of crude petroleum averaged 5,270,000 bbl a day, based on preliminary figures. This represents an increase of 480,000 bbl a day, or 10 per cent over the same two months of 1946. To supply the consumers with petroleum products, the committee noted, refineries operated at almost the same level as crude output, which was also an increase of nearly 500,000 bbl a day over September and October of the previous year.

This was summed up as evidence of the larger supplies that have been available.

Other highlights of the report follow:

"Six months ago, the Bureau of Mines reported in its forecast covering the latter part of 1947, that 'the limiting factor is refinery capacity' and based its estimate of probable supply during the last quarter of this year on average refinery runs to stills of 5,000,000 bbl daily.

"In other words, the bureau contemplated in June that potential oil consumption at this time would be limited by a refinery output of 5,000,000 bbl daily. Actually, as pointed out, refinery operations during the past two months have substantially exceeded this June estimate and have made available a correspondingly greater supply of petroleum products.

"There is no question as to the steadily rising trend of oil demands since the end of the war. The latest preliminary figures point to a probable motor fuel consumption of perhaps 2,500,000 bbl daily in September and 2,450,000 a day in October, 1947, more than 2 per cent above the same months of 1946.

"September and October demands for kerosine, light and heavy fuel oils may approximate 2,350,000 and 2,600,000 bbl a day, respectively, an increase of almost 25 per cent over the abnormally low level that prevailed in those two months of last year.

"These heavy demands have resulted in stock levels of refined products lower than a year ago. Storage of the four principal products—gasoline, kerosine, distillate, and residual fuel oil, including heavy crude in California—totaled 225,045,000 bbl on October 25, 1947, as compared with 236,863,000 bbl at the end of October, 1946.

"In the area east of California, total inventory of these products on October 25 was 167,151,000 bbl, about 12,000,000 bbl below the closing level for October of last year. Total crude stocks are approximately the same as a year ago.

"Almost six years of restrictions and limitations on the industry's ability to expand have prevented the construction of the new facilities needed to meet the mounting requirements. Throughout the war, prices for crude petroleum were frozen at subnormal, depressed levels. The supply of materials, particularly steel products, has been inadequate.

"The inevitable result has been various supply difficulties but it is important not to lose sight of the fact that an ever-increasing volume of petroleum products is going to the consuming public.

"As shown above, oil supplies are exceeding expectations and averaging 10 per cent in excess of 1946 output."

● **HARRIMAN SUPPORTS EXPORT CONTROLS.** Secretary of Commerce Averill Harriman, in his first quarterly report to congress under the second decontrol act of 1947, states that the uncontrolled exportation of petroleum at this time would have an adverse effect on the nation's economy, and defended recent department action placing these items on the export control list. The volume of petroleum required to meet export demands, he said, is needed to maintain prosperity levels of output, income, and employment in this country.

Harriman emphasized, however, that certain petroleum products must be permitted to move abroad to aid in economic reconstruction. He cited the fact that American firms operating abroad must be kept supplied and that American airlines, for example, must have aviation gasoline from this country if their foreign operations are to be maintained.

He said that stringent export controls were reimposed in the third quarter on gasoline, fuel oil, kerosine and certain other petroleum products as a means of protecting the domestic supply and to "permit exports to be used most effectively in the interest of world recovery."

● **N.P.C. SUPPLY COMMITTEE.** The National Petroleum Council through its chairman, W. S. Hallanan, has appointed a 21-man committee on petroleum products supply and availability. The committee will be charged with the responsibility of studying, reporting, and making recommendations concerning measures that can be taken by the government, the industry, and the public to conserve supplies of petroleum products or increase their availability. The committe is headed by Frank M. Porter of Oklahoma City, president of the Mid-Continent Oil and Gas Association.

● **SOCONY-VACUUM ALLOCATES PRODUCTS.** In view of the unprecedented demand for petroleum products and the greatly increased requirements of the federal government, which must have priority, Socony-Vacuum Oil Company, Inc., to effect the most equitable distribution of its products, has announced that in its eastern marketing territory, it will allocate gasoline to its present dealers and direct customers during November and December on a basis of 4 per cent less than the quantities delivered in the same months of 1946 subject to necessary adjustments to reflect current trends. The allocation also includes aviation gasolines, naphthas, and diesel fuels. It is planned to deliver kerosine and heating oils to the company's present customers during the current heating season on an equitable basis reflecting as nearly as possible the amounts they received for the 1946-47 heating season (June 1, 1946 to May 31, 1947)

A. L. Nickerson, director in charge of domestic marketing, said that the company will continue actively to study the supply and demand situation and during the latter part of December will announce the basis for allocation of products after January 1, 1948. It is improbable, however, that allocation after the first of the year will be any higher than at present, he indicated.

Nickerson said that the demand for petroleum products is greater now than ever before in history, including even the peak war year 1945.

"At the same time," he pointed out, "the supply of crude oil is at a record level and more petroleum products are being refined and delivered today than at any time in the past. In addition, Socony-Vacuum and other companies in the industry are expanding their facilities for manufacturing, transporting, and storing as fast as possible, spending some four billion dollars this year and next on this program; but the demand for petroleum products is currently running ahead of supply."

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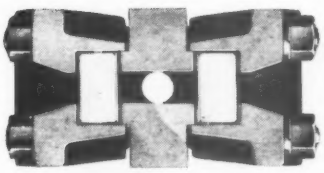

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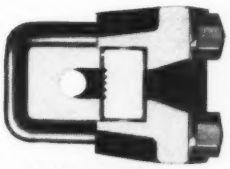

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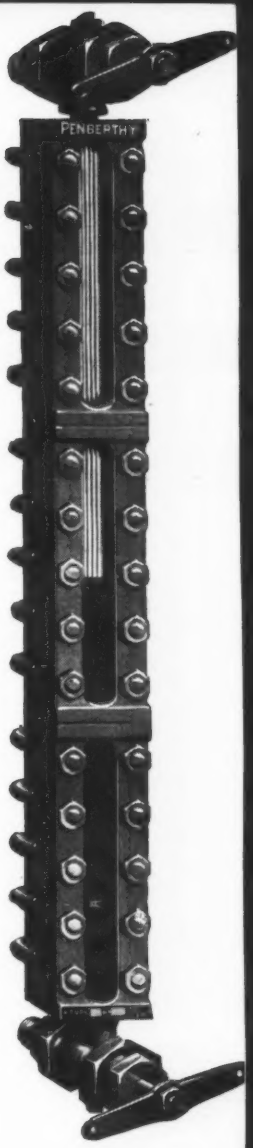
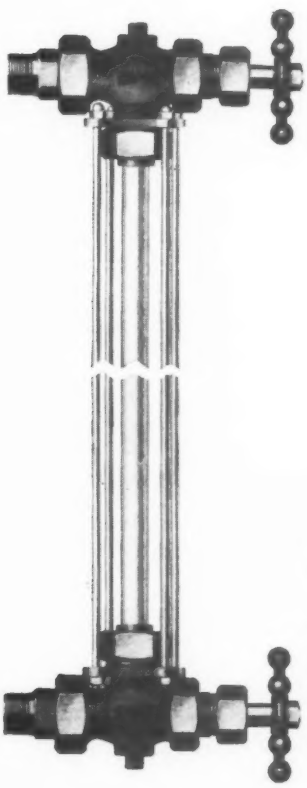
DROP FORGED STEEL LIQUID LEVEL GAGES

Liquid shows black—empty space shows white. Preferred wherever liquid level must be easily and positively visible . . . and when liquids are under high pressure or at high temperature.





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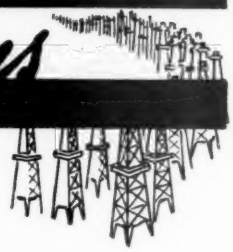
current oil field operations



Exploration wells that have found production.

● **UTAH.** Taylor Bros. 1 State C NW 33-21s-23e on S. Cisco structure, Grand. 300 ft oil in hole Ferron lime 1700 ft.

● **KANSAS.** Continental 1 Eva Gick NE NE NE 30-9s-19w Rooks. 611 BOPD 34° Arbuckle 3578-86 ft.

Bennett & Roberts 1 Esfeld SE SE NW 15-16-11w Barton. Est. 100 BOPD Arbuckle 3343-60 ft.

Rex & Morris et al 1 Robinson NW NE NW 36-25-3e Butler. 25 BOPD Mississippi 2694-723 ft.

R. L. Williams 1 Ehly SE NW 9-18-11w Barton. DST 200 ft 46° oil Kansas City lime 3099-105 ft.

● **LOUISIANA.** Phillips 2 Onezime, Crowley field, Acadia. 31 B cond & 4950 MCF gas PD 11,054-70 ft. New sand.

Stanolind 1 Watkins 23-13s-1w Vermilion. 65 B 56° cond & gas 7070-73 ft. New sand.

Pan American 1 Eva Rugg C NE SE 31-20n-1w Union. 200 B 59.5° cond PD Bodcaw 8386-404 ft.

● **OKLAHOMA.** Stanolind 1 Briscoe Unit C NW SE 4-4n-5w Grady. 5 hr DST 107.42 B oil and 3 MMCF gas from 13,879-904 ft. World's second deepest producer. Deepest oil production.

Western & Gulf 1 Hamilton NW SE SW 11-3n-2w Antioch NW pool, Garvin. 1 hr DST 1 MMCF gas and 20 B oil 1st Bromide 5757-77 ft. New sand.

Keener 1 Jackson NE SE NE sec 29, Logan. 250 BOPD 2090 ft.

Art Logan 1 Logan NE SE SE 25-8n-7e Logan. Swb 35-40 BOPD 3065 ft.

Midstates 1 Marshall NE NE NW 31-6n-4e Pontotoc. 70 BOPD 3240-46 ft.

Magnolia 1 Miller SE NW NE 14-6n-9w Caddo. 1½ hr DST 3275 ft oil Pennsylvania 10,625-35 ft.

Sunray 1 F. Romine NE NW SE 19-11n-2w Garvin. 60 B 22° oil in 12 hr Arbuckle 1762-80 ft.

O. E. Dempsey 1 Osage SE SE SE 15-20-10 Osage. 150 BOPD and 7125 MCF gas Tucker 2173-86 ft.

Carter 1 J. J. Harrison CSW SW 31-5-3w McClain. Swb 81 BOPD 9997 ft.

W. Duncan 1 Fitzsimmons SW SW SE 23-2s-11w Cotton. 80 BOPD 1876-85 ft.

Byrd Frost & Gulf 1 Mayberry-Tippett NW Crockett. Flowed oil on DST Wolf-Camp 6309-99 ft.

● **ILLINOIS.** Calvert-Willis Drlg et al 1 Yunker NE NW NE 14-3n-8e Richland. 85 BOPD McCloskey 3000-30 ft.

Dirickson & Slape 1 Buester SE NE 2-4n-8e Clay. 735 BOPD McCloskey 3019-25 ft.

● **INDIANA.** Barsland 4 F. Philpott 21-27n-4e Miami. 100 B oil in 8 hr Trenton 840-48 ft.

W. A. Schuller & H. W. Ramsey 1 Frank Steiner NW NW 24-2s-10w Gibson. 30 BOPH McCloskey 1956-62 ft.

Princeton Mining 1 McCarty SW SE NE 13-2s-11w Gibson. Flowed on DST O'Hara 2000 ft.

● **MONTANA.** Texas 1 Colbry SW SW 13-36n-6e Liberty. 9 MMCF gas Colorado 2820-3045 ft.

● **NEW MEXICO.** Petroleum Products 1 Santa Fe SE SE NW 21-21n-8w, San Juan. Bailed 10 BOPD 4700 ft.

● **WYOMING.** California & Phillips 1 Christiana NE SE 8-17n-77w Albany. 100 BOPD Muddy 5818 ft.

Continental & General Pet 1 Unit NW SE SE 26-27n-93w Fremont. 20 MMCF gas Tertiary 2157-80 ft.

Rocky Mountain Gas well, Hatfield Dome field, Carbon. 250 BOPD 43° Tensleep 5805-6072. New sand.

● **TEXAS.** Gulf 20-B-E Connell, sec 26, blk B-16, PSL sur. Ector. DST 131 B oil 1½ hr & 1400 MCF gas PD Tubb sand 5245-94 ft.

H. L. Hunt 1 Hunt-Wilson, n of League City field, Galveston. Large amount gas and 45° cond 9654-62 ft.

Joe Moss et al 4 Amalia B. Veda, El Grullo grant, Zapata. 30-50 BOPD 761-66 ft.

Sinclair Prairie et al 1 Skelly-University C NE NW 25-13 U Andrews. 1036 BOPD Devonian 9700-9840 ft.

Texas 1-U University C NW NW 22-40-U Crockett. 135 ft oil Ellenburger 8785-8840 ft.

Hawkins-Graham 1 C. G. Hooks, F. H. Green sur, Hardin. 156 BOPD 40° Cockfield 5400-10 ft.

Standard of Texas 1 H. L. Rising, McAnair sur, Grayson. 22 BOPH Strawn 3217-25 ft.

Pan American 1 H. Campbell, Runnels, 2 hr DST 540 ft oil Ellenberger 4581 ft.

Stanolind 1 Slaughter, White sur. Harrison. Testing, 4450 MCF gas & 84 BOPD 6358-86 ft.

Los Nietos 1 J. A. Sparks 396-G-CCSD&RGNG Gaines. Swb 4 BOPH 6860-6934 ft.

Pure-Humble 1-EA Cowden. Andrews. DST 94 BOPH 44.8° Ellenburger 11,166-206 ft.

A. Goldsmith 1 R. L. Kempner 55-KWVFL Wichita. ½ hr DST 210 ft oil Strawn 3916-36 ft.

R. C. Lipscomb 1-C McCall, blk 132, Montague. 15 min DST 200 ft oil New Bend 6099-6108 ft.

Hunt 1 Oliver Black, Sand Flat field, Smith. 78 BOPD Bacon 9096-116 & 9132-40 ft. New sand.

Slick & Urschel 1 Plymouth-Alford 50½-Y-Scott, Upton. DST oil & gas 11,276-312 ft and est. 11 MMCF gas PD & 53.8° cond Ellenburger 11,166-206 ft.

McDannald 6 Martin, S. Hutchins field, Wharton. 192 BOPD 30°, 5896-98 ft. New sand.

Fox & Fox 1 Griffin, sur 589, Shackelford. 35 B oil in 6 hr Ellenburger 4480-505 ft.

J. W. Mecom 1 Ker Cade-8-A, Isaac sur, Galveston. 87 BOPD 7140-46 ft.

Standard of Texas 1 Hartburg Lbr, H&PB sur, sec 3, Newton. 6 hr test 1500 MCF gas 7171-81 ft.

S. D. Johnson & Acme Die and Machine 1 Carl Mobley, T. Moorhead sur, Clay. 1 hr DST 180 ft oil 3430-60 ft.

Tide Water 1 B. A. Johnson, ne of Sublime field, Colorado. 82 B oil 9495-500 ft.

Falcon Seaboard & Dunwoody 1 Sun-Bashara, Hardin. 95 BOPD 33.2° 7312-80 ft. 131 BOPD 35.9° 7112-84 ft.

C. Andrade III & M. G. Hansbro 1 A. B. Hunter SE NW 27-T&NO, Jones. 50 BOPD 2210 ft.

C. Andrade III & M. G. Hansbro 1 Monroe 13-2-H&GN. DST oil and gas Delaware 3880-98 ft.

Seaboard 6-E-A Robinson 37-34-5N-T&P, Sprayberry field, Dawson. 18 hr DST 30 B oil 10,590-630 ft. New sand.

Stanolind 1 Central Coal & Coke, West Mercy field, San Jacinto. 111 BOPD 38° 8337-46 ft. New sand.

L. M. Josey & M. T. Halbouty 1 W. G. Christian, J. Milhome sur, Hardin. 90 BOPD 28° 2800 ft. New sand.

Lone Star 1 Killough, Walters sur, Henderson. 20 BOPH Bacon 8193-205 ft.

Sam E. Wilson 1 Hearne, Baker sur, Harrison. Large amount of gas and cond Pettit 5776-5803 ft.

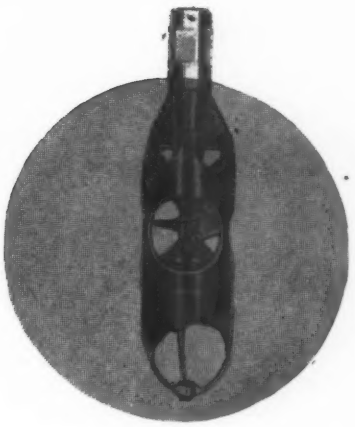
J. H. Snowden & L. H. Freedman et al 1 Marrs, blk 289, BBB&C sur, Throckmorton. 1 hr DST gas and 3260 ft oil Pennsylvanian 4626-36 ft.

● **ARKANSAS.** A. E. Stewart et al 1 B. Johnson C NE NE 29-16s-25w Miller. 10 BOPH 3990-4000 ft.

Whitley et al 1 Duncan NW SE SW 3-15n-27w Madison. 3 BOPD Sycamore 450-632 ft.

● **GULF OF MEXICO.** Kerr-McGee 1 State, lse 754, blk 32, 12 mi off Terrebonne Parish, Louisiana, shore. Sands logged between 15 & 1600 ft and 1650-1700 ft.

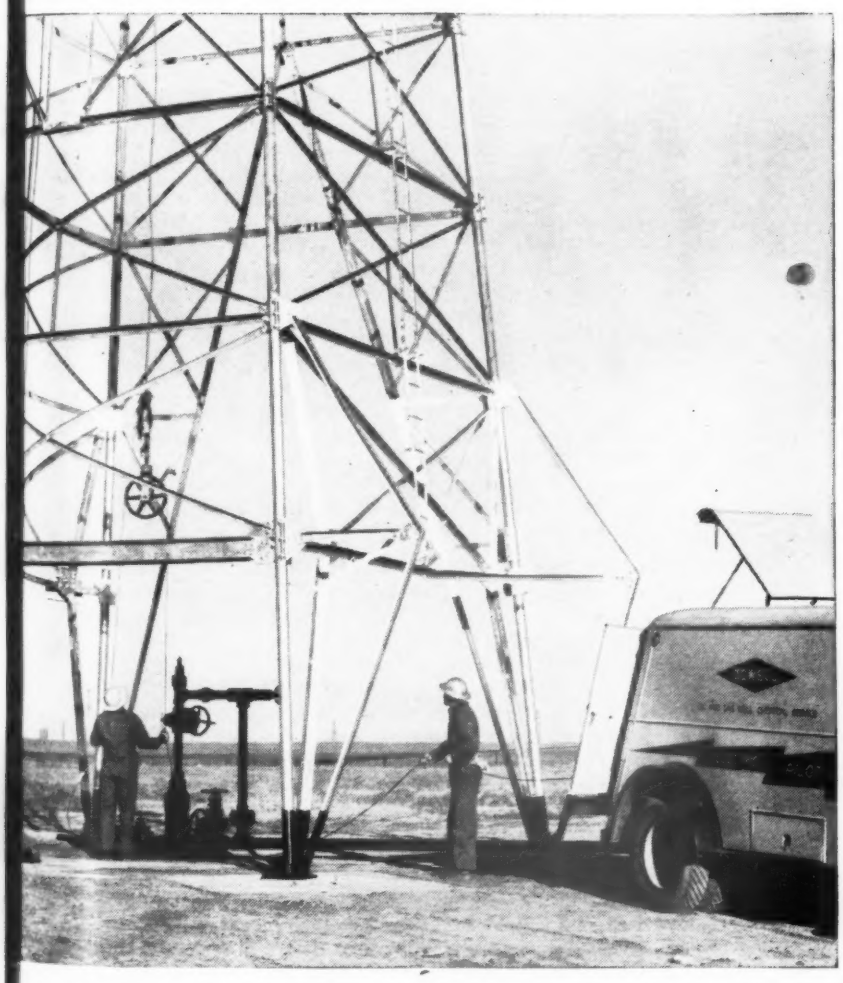
● **VENEZUELA.** Socony-Vacuum of Venezuela 2 Silvestre, Barinas area, western Venezuela. TD 9766. Testing.



FLOW RATE INDICATOR

For produced or injected fluids in your well.

Dowell Spinner surveys— chart subsurface fluid flow



Dowell's Spinner, pictured above, is an efficient subsurface flow rate indicator for well fluids, including gases. It is used to locate the points of fluid movement from and into formations and to measure the rate of flow.

The small propellor-like "spinner" is turned by fluids passing it (as the fluids are produced or injected), and the revolutions are recorded at the surface in the Electric Pilot truck.

Spinner Surveys may indicate: the relative permeability of each zone in producing or input walls; the relative production of zones in producing wells; the location of zones of lost circulation, holes in pipe and leaks in casing seats and bottom hole plugs; the relationship of a bottom hole plug to a set of perforations.

For information about the application of a Dowell Spinner Survey to your well—call the nearest Dowell station. Ask for your copy of the new booklet describing all of the "Electric Pilot Services."

GAS WELL EXAMPLE:

A Dowell Spinner Survey in a gas well revealed the production capacity of each of four exposed producing formations. The results of the survey were used as an aid in determining acidizing procedures.

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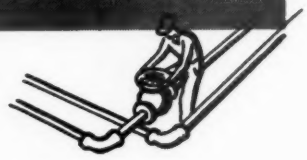
pipeline developments



● **EXPANSION PROPOSED BY TENNESSEE TRANSMISSION.** Tennessee Gas Transmission Company has asked the Federal Power Commission for permission to increase the capacity of its natural gas pipe line system by 450,000,000 cu ft daily to meet the additional demands of customers and to serve new markets in Eastern New York State and New England.

The company is now at work laying a parallel line to its original carrier, which extends from the Rio Grande Valley in Texas to West Virginia, to give it a capacity of 600,000,000 cu ft daily. It is now asking the FPC to authorize facilities to increase its system's deliverability to 1,055,000,000 cu ft daily, and to build an extension through Ohio, Pennsylvania, New York, and Massachusetts to a terminal near Boston. Construction will begin as soon as the permission is granted, the application states.

The company asks permission to:

1. Construct five new compressor stations with a total of 50,000 hp installed and to add to its existing stations new compressor units totaling 125,200 hp.
2. Lay approximately 770 miles of 30-in. main line loop and approximately 124 miles of 26-in. main line loop along the existing pipe lines, beginning at a point near Corpus Christi and extending to the company's Station No. 14 at Burnaugh, Kentucky.
3. Lay an extension of approximately 170 miles of 26-in., 480 miles of 24-in., and 140 miles of 20-in. new line from Burnaugh, Kentucky, to a point near Boston.
4. Build a 65-mile, 16-in. spur from a point in Eastern Ohio to a point near Pittsburgh, Pennsylvania.
5. Construct various lateral gathering lines and facilities in the Southwest to tap new sources of gas supply.

Estimated cost of this new construction was fixed at $150,000,000. The Tennessee Gas Transmission Company proposes to finance a portion of this cost out of operating funds and the remainder from new securities and bank loans.

The company said it would supply the new markets from its presently dedicated reserves in the Stratton-Agua Dulce, Carthage, San Salvador and Seeligson fields in Texas, and from more than thirty other fields in the Southwest.

● **AUTHORIZATION FOR INCH LINES MADE.** The Federal Power Commission has authorized Texas Eastern Transmission Corporation, Houston, Texas, to acquire and operate the Big and Little Big Inch lines to transport natural gas from the Southwest to gas companies operating in the Midwestern, Appalachian and Philadelphia areas, and to construct facilities to increase the delivery capacity of the lines to approximately 435,000,000 cu ft of gas per day.

Some interveners in the proceedings had contended that gas service should not be extended to Philadelphia until full requirements of consumers in the Appalachian area had been met.

The Commission disagreed with the contention of some of the contracting companies that the FPC is without authority to question these companies' rights to the quantities of gas specified under the contracts. Texas Eastern accordingly was directed to provide for gas deliveries to four companies in Illinois, Indiana and Missouri.

The Commission also pointed out that the shortage for the coming winter in the area served by Panhandle Eastern Pipe Line Company will be greater than last winter's. Consequently Texas Eastern was ordered to continue delivery of 20,000,000 cu ft of gas daily to Panhandle by displacement.

● **TENNESSEE EXPANSION PLANNED.** Mid-East Tennessee Natural Gas Company proposes to construct a trunk transmission line approximately 106 miles in length from Southern Natural Gas Company's proposed facilities near Chattanooga to Knoxville, Tennessee.

The trunk line would pass through Cleveland, Athens, Sweetwater, and Maryville to Knoxville. Its size would depend upon the gas pressure at the intake, the company indicated, and in the event that 200 lb is available, it is probable that a 10¾-in. line would be preferred. Initial delivery capacity of the line would approximate 25,000,000 cu ft daily with the use of a single compressor station. Installation of a second compressor station would increase capacity to 30,000,000 cu ft daily, which the company believes will meet market requirements for a period of several years.

● **KENTUCKY-VIRGINIA LINE PROPOSED.** Commonwealth Natural Gas Corporation, a new company, proposes to construct a 537-mile pipe line from Tennessee Gas Transmission Company's trunk line at West Bend, Kentucky, to Norfolk, Virginia, in an application filed with the Federal Power Commission.

Commonwealth Natural was formed for the purpose of building the Norfolk line. Its officers and directors are Michael E. Shea, president; James O. Watts, Jr., vice president; James R. Caskie, secretary; and Robert C. Watts, Jr. and Henry Sears, directors. All officers are directors.

Contracts presently are being negotiated by Commonwealth Natural with Roanoke Gas Company, The Petersburg and Hopewell Gas Company, Virginia Electric and Power Company, Suffolk Gas Company, the City of Richmond, Portsmouth Gas Company, and a number of large industrial customers.

The proposed facilities are described as 20-in. pipe line with laterals to Roanoke, Petersburg, Richmond, and Suffolk, Virginia. The estimated cost of the pipe line with appurtenant facilities would be $29,522,100.

● **GAS STORAGE FACILITIES TO BE INCREASED.** The Ohio Fuel Gas Company has filed an application with the Federal Power Commission requesting authorization to construct facilities to develop new underground storage capacity to permit receipt of additional pipe line gas during the summer months and to improve the ability of the company to meet requirements of existing markets and consumers. Construction costing approximately $2,310,800 is contemplated.

Facilities for which authorization is sought are:

1. A natural gas compressor station in Monroe Township, Richland County, Ohio, to serve as a repressuring station for the Perrysville storage area. The station would consist of five compressor units totaling 6350 hp.
2. Approximately 22 miles of 16-in. gas transmission line in Knox and Richland Counties, Ohio.
3. Extension of the present storage area by the addition of 13 partially depleted producing wells. The wells cover a surface area of about 1500 acres and have an estimated capacity of 1½ billion cu ft when repressured to 1050 lb per sq in.

● **SINCLAIR PLANS PRODUCTS LINE.** Construction of a 10-in. petroleum products pipe line from the Sinclair Company refinery on the Houston, Texas, ship channel to Arlington, near Fort Worth, will begin soon.

The Sinclair Company disclosed it has asked bids on the 260-mile carrier. Estimated cost will be $5,000,000. The line will have a daily capacity of about 50,000 bbl. A terminal will be established at Bryan. Construction is to be started before the end of the year. This will be the third pipe line to the Dallas-Fort Worth area.

Sinclair also announced it has completed construction of an 8-in. line from Corpus Christi to Austin via Gonzales and Luling.

● **MARINE TERMINAL NEARS COMPLETION.** Excellent progress is being made in the construction of The Texas Company's marine terminal under construction on the St. Louis, Missouri, waterfront in the vicinity of Gasconade Street and company officials anticipate that it will be complete and in service about March 1, 1948.

It has been estimated that the terminal, which will have facilities to serve as a supply center for tank trucks, railroad cars, and river barges, will cost upwards of $500,000. The Chicago Bridge and Iron Company, Chicago, supplied all of the labor and material on the erection of eight large storage tanks, two being one-roof tanks and the remaining six of the floating roof type.

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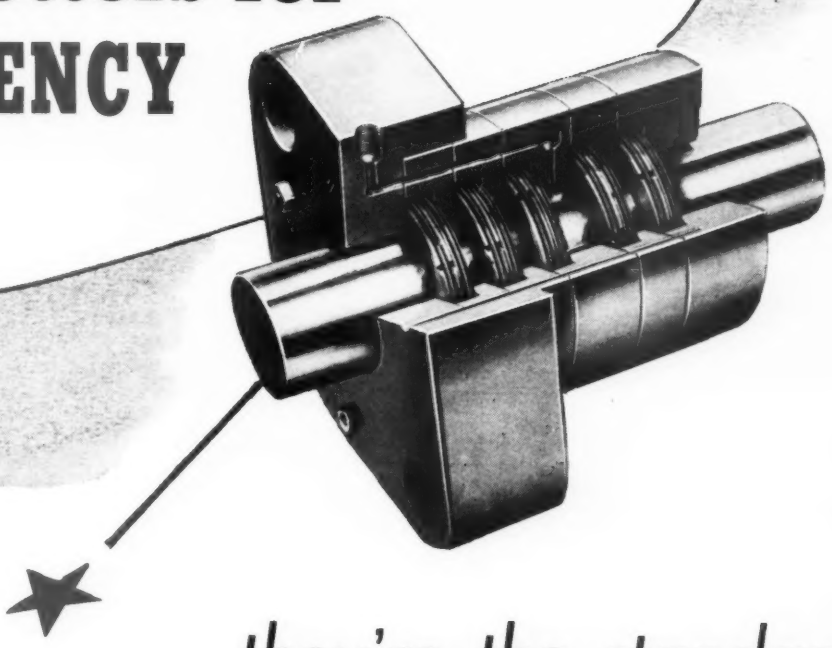

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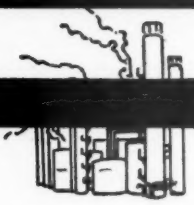
refining and natural gasoline activities



● **PHILLIPS AND ATLANTIC PLAN PROPANE PLANT.** A long-term contract announced jointly by Phillips Petroleum Company and the Atlantic Refining Company provides for construction of a modern propane plant in the Philadelphia area and marketing of its production in tankcar and tank truck quantities. The plant will be an addition to Atlantic's present Philadelphia refinery and will make this company a leading producer of propane on the eastern seaboard. Phillips will build a 500,000 gal propane storage and loading plant adjacent to Atlantic's Point Breeze refinery. Tankcar and tank truck shipments will be made to Phillips customers from the new bulk plant.

● **SUNRAY REFINERY AND LINES BEGIN OPERATIONS.** Crude oil from the Velma pool of Stephens County has already started flowing into storage tanks at Sunray Oil Corporation's new refinery at Duncan, according to an announcement by Floyd L. Martin, Sunray vice president directing refining activities.

The crude is being pumped through Sunray's recently completed 6-in. pipe line joining the refinery and the Velma pumping station 17 miles away. The line is being extended on from Velma direct to Sunray's second Oklahoma refinery at Allen. The line will serve as a products exchange line between the two plants.

The completed line will be 94 miles long, with double lines from Velma to Duncan, and more than 43 miles have already been laid. The line is expected to be completed about December 15. The new pipe line, along with other lines, will deliver approximately 20,000 bbl of crude and gas oil to the Sunray plant daily. The line will be "reversible" and will carry gasoline from Duncan back to Allen for further processing. Sunray also operates a products line from Allen, which connects with the Great Lakes transportation system lines at Drumright.

With 320,000 bbl of crude storage already available on the Duncan refinery site, Sunray is constructing tankage for an additional 240,000 bbl. This will be built up and held in storage as a backlog on which to begin refining operations on or before January 1, Martin said.

● **CRACKING PLANT GOES INTO OPERATION.** Lion Oil Company has placed a catalytic cracking plant in operation at its refinery in El Dorado, Arkansas, Colonel T. H. Barton, president, has announced. Cost of the new cracker, which required nearly a year to complete, was $1,500,000. In the last 30 days the accelerated drilling program of Lion Oil has resulted in the completion of 12 new producing wells and one dry hole.

● **PETROL REFINERY BEING RENOVATED.** T. Ellwood Webster, president of Catalytic Construction Company, subsidiary of Houdry Process Corporation, has announced that work has begun on the Texas City refinery of Petrol Terminal Corporation, which the latter recently purchased from War Assets Administration. The plant includes a six-case Houdry fixed-bed catalytic cracker and work will embrace inspection, repair, and testing of the catalytic unit as well as the alkylation plant and gas plant.

The unit has been down for two years and modernization will be included in the maintenance work by Catalytic Construction engineers. It is expected that the plant will be back on stream in less than 90 days.

Catalytic Construction has also begun maintenance work at Socony-Vacuum Oil Company's Buffalo refinery, changing catalyst and making complete repairs to Houdry fixed-bed cases. While the work is being done on a one-shift-per-day basis the job will be completed in less than six weeks.

● **STANDARD AFFILIATES SET NEW REFINERY RECORD.** With the oil industry operating at its highest level in history to meet unprecedented demands for petroleum products, refineries of domestic affiliates of Standard Oil Company (New Jersey) processed 19,900,000 bbl more crude oil the first nine months of this year than during the corresponding period in 1946.

This added volume represents increased production in various petroleum products. For example, it provided sufficient additional gasoline for average operation of more than 330,000 automobiles for one year.

Refineries of Jersey affiliates handled nearly 12 per cent more crude oil during this last 9-month period than they did during the same period in 1946, which was the third successive year that they set a new annual record. The average amount of crude oil run through the affiliates' domestic plants during the three-quarter period was 704,000 bbl a day, compared with 631,000 bbl a day for the corresponding period last year.

● **OKLAHOMA REFINERY MAKES RECORD RUN.** The three-furnace Dubbs thermal cracking unit at Sunray Oil's Allen, Oklahoma, refinery has hung up its longest continuous run on record, it is announced by F. L. Martin, vice president. The cracking unit had been in uninterrupted operation since June 7, the run continuing to October 7.

During the record run of 121 days and 17 hours, a total of 1,075,758 bbl of crude was processed, or an average of 8836 bbl daily. Of this total, the gasoline yield amounted to 59.12 per cent, or nearly 27,000,000 gallons. The previous record was made from May 10 to September 1, 1946, a total of 113 days, 9 hours, when the unit processed 777,511 bbl of crude with a gasoline yield of 58.04 per cent.

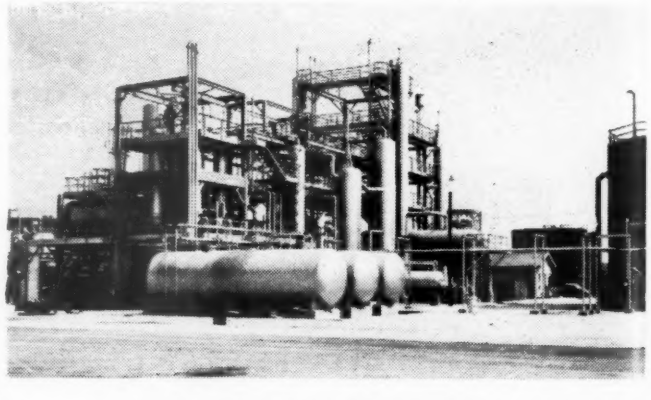
The unit, the first three-furnace thermal cracker to be built in the United States, was erected in 1945, and has a rated daily cracking capacity of 7000 bbl. Dewey Vinson is superintendent of Sunray's Allen refinery, and T. L. Tiernan assistant superintendent.

● **GENERAL PETROLEUM COMPLETES UNIT.** Another unit in the development and expansion of General Petroleum Corporation's Torrance, California, refinery was put into commission late in September when a nominal 5,000 bbl a day Edeleanu plant went into operation. Total cost of the unit and its appurtenances approximated $2,250,000 with construction and basic design features handled and supplied by E. B. Badger and Sons Company.

Concerning the new unit, Gale L. Adams, assistant manager of manufacturing of General Petroleum, said: "Within practical limits every effort has been made to incorporate flexibility in so far as concerns types of charge stocks, that may be successfully processed and also the range of solvent treatment to which each stock may be subjected.

"In operation it is expected that the solvent to oil ratio may vary between limits of from ½ to as high as 2 to 1 with, of course, certain variations in the oil charge rate. Products which may be produced as occasion arises will range from solvents (both paraffinic and aromatic), kerosene, agriculture spray oils, and diesel fuels. Diesel fuel of 50 cetane number or higher as occasion requires will be produced."

Edeleanu plant goes into operation, Torrance, California.



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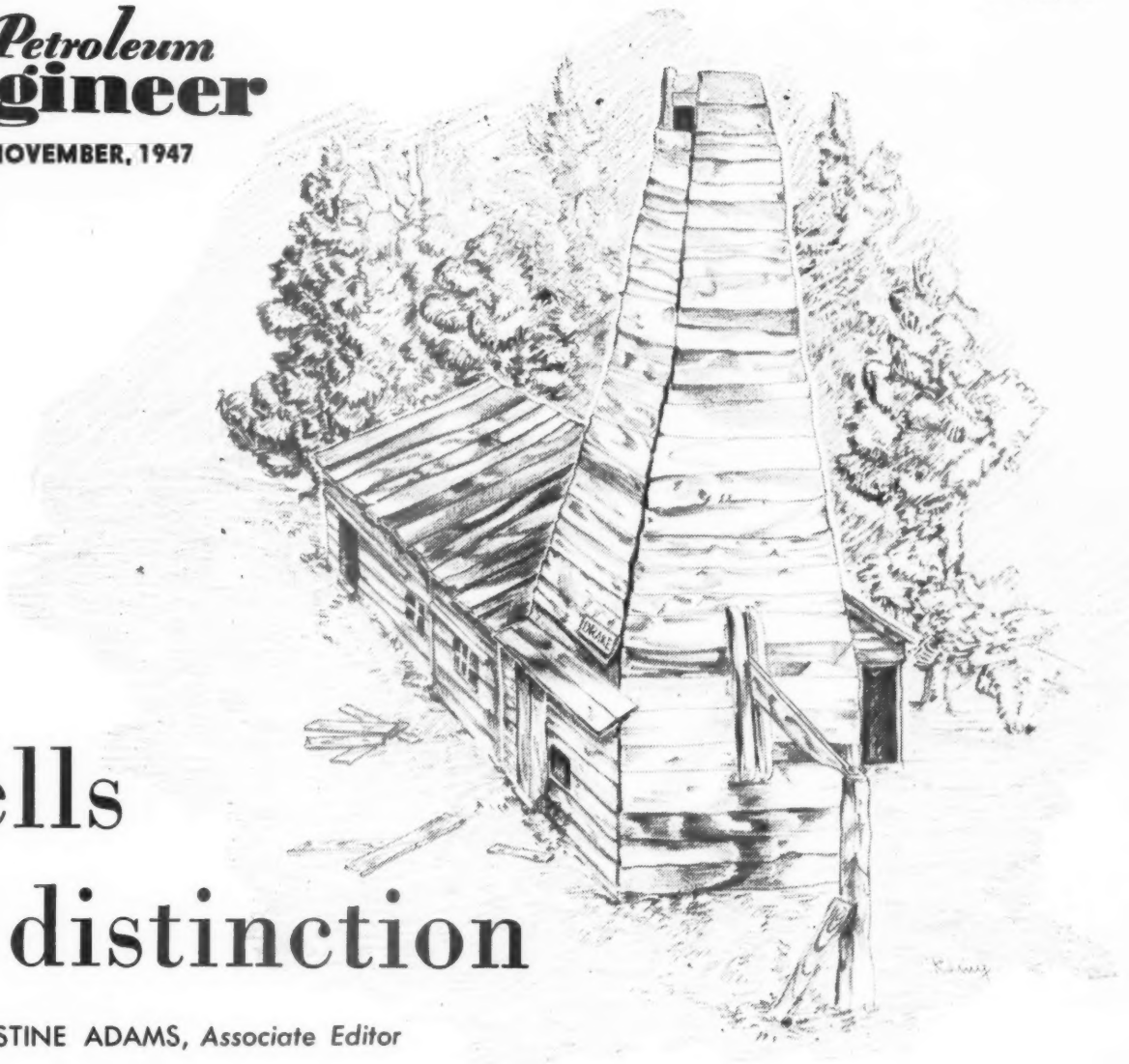
NOVEMBER, 1947



Wells of distinction

By ERNESTINE ADAMS, *Associate Editor*

IN THE massive archives dealing with oil wells of the world there is small indication of the color and imagination that spilled so lavishly through their varied records. The **EXCLUSIVE** account of methods and statistics and factual history are vital reflections of the industry's progress in drilling and production but they present a gray picture of the individual wells that lighted up the rise of petroleum.

Some of these wells have drawn special attention by record-breaking production or depth, some have required new and distinctive methods of engineering and thus advanced the technical knowledge of the industry. Some wells have gained fame by pure devilishness.

It is past time to collect the stories of the wells that mark the industry's advance because memory of the old ones dim in the light of more recent drilling.

A drilling crew finds that nearly every well builds up a character of its own as the drill goes down. It may be smooth or cranky, docile or perverse, lucky or jinxed. It symbolizes the success or failure of man's efforts to draw upon nature's hidden deposits.

Every oil operator could recount the history of fearful and wonderful wells he has known. A few colossals will be remembered by many. No one who saw the roaring volcanic Mary Sudik in the Oklahoma City field will likely forget its reckless power. Nature held man off for 11 days while black gold rode the winds and brought more grief than gain to the I.T.I.O. Company. But it was the Mary Sudiks that brought into development the equipment and technical know-how to save the oil in other high pressure fields.

Many remember the embarrassing riches that poured in floods from the Lake View oil gusher at Maricopa, California. Even nature's own canyons, dammed to hold the torrent of oil, were not enough and much was lost in the lowlands. The new experts regard such waste with righteous indignation but a problem must be presented before it can be solved.

It is in Mexico that we find the all-time champion gushers. Aguila Company (British interests) No. 4 Portrero del Llano began flowing at the rate of 100,000 bbl daily in December, 1910. Over 100,000,000 bbl were produced by the well in the next eight years.

The top rate of production—300,000 bbl a day—was credited to Huasteca Petroleum (Mexican Petroleum Company) No. 4 Cerro Azul in the Cerro de la Pez. It was discovered in February, 1916. The rate could only be estimated but it indicates the size of this one among several giants in the Mexican fields developed by British and American in-

Editor's Note

No one article can hope to include all the oil wells that have some claim to distinction. The oil industry of the United States has progressed upon the knowledge gained from each new well that did not follow the expected pattern. There are many that produced new problems instead of oil and others that produced answers to questions more important than any oil they might yield. If you know a well that has been missed in this collection that deserves mention, we should like to give it recognition in a subsequent issue of *The Petroleum Engineer*.

OIL MAN'S TEST

1. Can you name two wells, each of which is estimated to have produced 300,000 bbl a day—one produced oil, the other hot salt water?
2. Which is the last state to enter the list of commercial oil-producing states?
3. What well has the deepest oil production and what well has the deepest gas and condensate production?
4. How many states have had wells drilled below 10,000 ft?
5. Can you name the states with production from below 10,000 ft?
6. What well is 27 miles from land?
7. What state celebrated the 50th anniversary of its oil industry this year?
8. What well in the Middle East is producing from below 10,000 ft?
9. Which state produced the most oil in 1899?
10. When was the first well drilled below 15,000 ft?
11. Is petroleum production found in Missouri below 1000 ft?
12. What state awarded a $50,000 prize for the first commercial oil well?
13. Two states have tests below 10,000 ft but have produced no oil from any depth. Can you name them?
14. What well drowned a man in the derrick?
15. Can you name the first well with production from below 10,000 ft?
16. Which state in the Rocky Mountain Region has the deepest production.

(Answers found in "Wells of Distinction," or in box on page 54)

terests. Another one of these was Sinclair Oil No. 3 Zurita, on the south shore of the Panuco River, which flowed over 23,000,000 bbl of 11 deg gravity oil the first 8 years of its existence.

There are more dignified wells in the hall of fame. Continental's A-2 Kern County Land piled up a handsome record. It was the first test below 15,000 ft and the first producer from 13,175 ft, opening the well known Wasco field in California. From 1938 to 1944 no deeper well was drilled. Though the old depth record champ is now retired, it is still producing and is doubtless a record cumulative producer of the super-deep wells.

Floridians at least will not soon forget their prize well. Humble Oil and Refining Company received a $50,000 award from the state for the first commercial well within its boundaries. The company immediately added an extra $10,000 and divided the whole between the University of Florida and the Florida State College for Women. For more than a score of years wildcatters had been drilling in Florida and the anxious state fathers dangled the extra prize, which would have been good pay for a well in earlier times. It wasn't until Humble drilled to 11,626 ft that oil was found in any quantity.

There have been some spectacular wild wells. Fire has at times turned heavy gas producers into holocausts that defied control. Texon Drilling Company had a well in the Agua Dulce field, Texas, that burned out two craters in the surrounding 90 acres and threw up an 8-ft dike around the area. Artesian wells near by, which had been pumped, began flowing and some had to be plugged.

About ten years ago there was a well that blew itself up. In Lake Maracaibo, Venezuela, the well came in at 1860 ft. Pressure was so great that the piling was undermined and the derrick and equipment sank in the lake.

In one search for oil a well in Mexico brought in a geyser. Penn Mex Fuel Company's No. 35 Jardin, near Vera Cruz, was in late 1931 the deepest test in the world at 10,585 ft and among the deepest ever drilled by cable tools. It began producing hot salt water and later made 300,000 bbl a day of 162 F salt water. At the time of drilling in one of the casing crew was aloft and drowned in the tremendous flow of water before he could unfasten his safety belt. Newspaper accounts related the "believe it or not" story of a man being drowned on a bright moonlight night, 60 ft in the air, and two miles from the nearest pool of water.

Not many could name at once the first well to pass the 10,000-ft depth but it was an important step in drilling history. Chanslor-Canfield Midway Oil Company No. A-2 Hobson, went to 10,030 ft in the Padre Canyon field, (then called Rincon field), Ventura County, California, in 1931 before the Jardin well reached that depth.

Although so far the method has made little headway, it might be interesting to remember the first horizontal well, which was set up on the George W. Havenner farm in Morgan County, Ohio, in 1939. The well was drilled into the outcrop of the Cow Run sand at a creek bottom.

Another history-making well is the Arabian American wildcat in Abu Hadriya, Saudi Arabia, 100 miles from any production. It was nearly abandoned before it came in from below 10,000 ft after penetrating 110 ft of oil sand. The deepest well in the Middle East, it is a reminder of the lower, untouched layers of wealth in that rich area.

The history of the oil industry could be told by a chronological listing of outstanding wells and what they did. Drake's at Titusville, Pennsylvania, initiated the industry on Sunday, August 28, 1859. It was only 69½ ft deep and pumped a mere 10 bbl of oil a day but it heads the story of a great industry. Not only was the Drake the first commercial oil well. It was also the first successful use of casing in a drilled well.*

The Hequembourg or Russell flowing well was the second well of note.† In August, 1860, this first flowing well came in, the oil gushing 20 ft into the air. The hole was 124 ft deep and production was estimated at 100 to 300 bbl a day. The Rev. Charles L. Hequembourg, Warren's Presbyterian minister, R. K. Russell, and others drilled the first flowing well. The following year Hequembourg was accused of preaching heretical ideas and left his church.

The next important well is hard to determine at this late date. It might be the well on the Buchanan farm along Oil Creek that began flowing at the rate of some 3000 bbl a day in April, 1861. The Merrick, or Rouse well as it was better known, caught fire and one of the lessees, Henry Rouse, was burned to death. Nineteen persons lost their lives in the fierce flames. Rouse dictated his will just before he died, leaving $180,000 to Warren County for benefit of the poor and for the improvement of roads.

Another famous well was known as the "646 Mystery Well." To quote Ernest C. Miller's† description: "It was located at Cherry Grove, Warren County, Pennsylvania. Closely guarded until the owners of this well had purchased additional land near by, it was announced on May 17, 1882, that it had come in with oil. The yield increased rapidly to 2000 bbl daily and this 'wildcat' started the famous Cherry Grove oil field, the output of which was fought over by the Standard Oil, Tide Water, and other oil interests. This was the most famous of the mystery wells in Pennsylvania and led to the formation of 'oil scouts.' These were men hired by the large brokers and all the large oil concerns, to report on new drilling activity and to get news of the failure or success of the wells prior to general release of such news to the markets."

In 1863 came the Reed well, which is said to be the first to have a charge of gunpowder lowered into it and exploded to increase oil flow.

A history could be written but it is not the purpose of this article. Already there are many missing records. It is too late to find all the wells that introduced new methods and new machinery or demonstrated new traits of nature concealed by the earth's surface. In Pennsylvania dependable records are found but by this

*J. P. Jones, director of production, Pennsylvania Grade Crude Oil Association.

†This is the choice of Ernest C. Miller of the West Penn Oil Company, Warren, Pennsylvania, who is an authority on the history of early Pennsylvania wells.

time wildcatters were swarming over many parts of the country and history is thinned out by distances.

This is a collection of wells that have claim to importance in more recent times, some holding records only in their state. It is a collection that any operator can add to and it is to be hoped that he will, so a record can be kept of the wells that by exhibiting individual characteristics have influenced the whole trend of drilling and production of oil.

● **Alabama.** It wasn't until February 15, 1944, that Alabama became an oil-producing state when the H. L. Hunt Company No. 1 Jackson began flowing from 5380 ft. This opened the Gilbertown field in Choctaw County, which produces oil of 17 API gravity from about 2550 ft.

So far the largest well in the state is the Carter Oil Company No. 1 F. M. Mosley with a production of 196 bbl a day. This well, completed in February, 1947, went to 3280 ft.

Deepest well in the state is Union Producing Company No. 1 M. M. Waite, a wildcat in Clarke County, which in 1941 went to 12,399 ft in the Jurassic formation but found no oil.

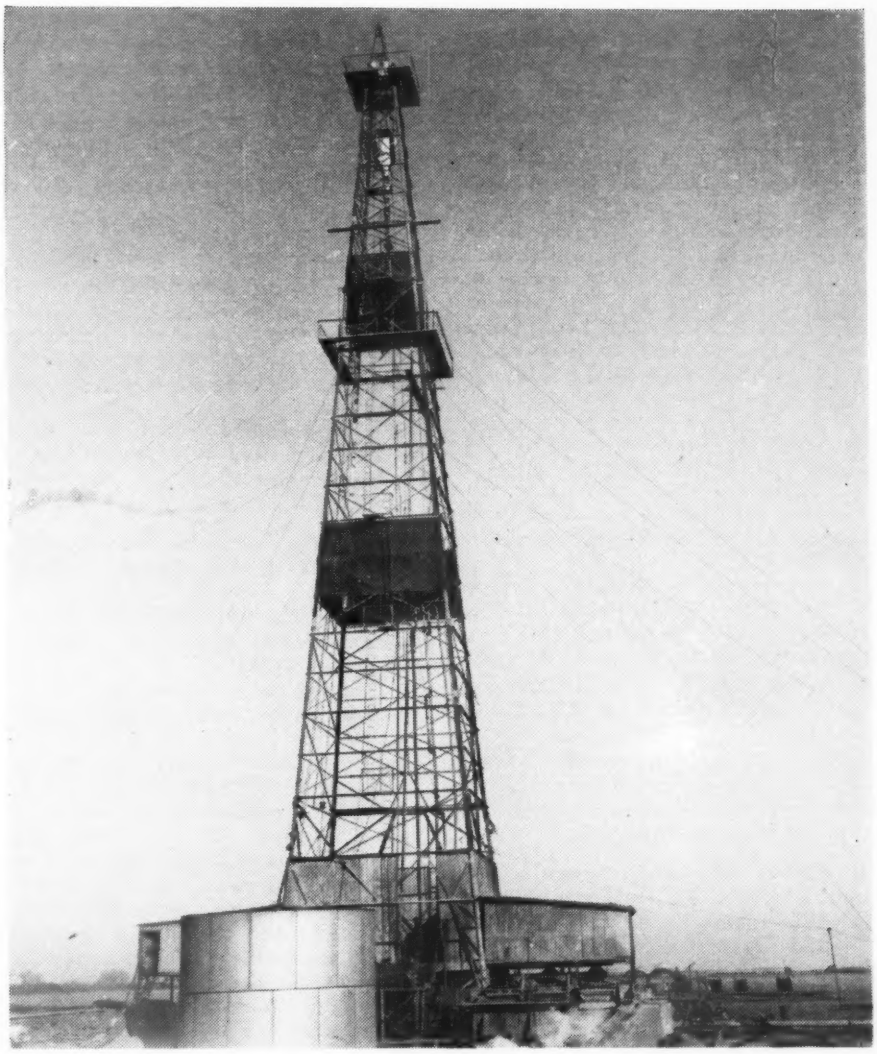
Producing depth record in Alabama is said to be the Hunt No. 4 Land in the Gilbertown field, drilled in 1945 to 3624 ft and producing from that depth.

● **Arkansas.** It was only two years after oil was discovered in Arkansas that one of the large fields of the world was found there. V.F.K. Oil Company No. 1 Richardson blew in on April, 1922 to open the famous Smackover field. The initial production of 500 bbl a day from about 2000 ft was the first of a series of gushers, one well reaching 30,000 bbl a day.

In recent years three wells in Arkansas have gone below 10,000 ft. One is Atlantic Refining Company No. 1 Montana Realty Company in Miller County, which has a total depth of 10,006 ft, an unsuccessful wildcat completed in 1945. Northern Ordnance No. 1 Waggoner, Columbia County, was drilled to 10,600 ft in 1943. A third, Union Producing Company No. E-1 Crossett Lumber Company, Ashley County, reached 11,136 ft in 1944.

Deepest production was found in 1942 at 9330 ft in the Smackover by Tide Water Associated Oil Company and Seaboard Oil Company of Delaware No. 1 Bandaw, Patton field, Lafayette County.

● **California.** A fair share of California oil wells, like its citizens, have displayed odd and sometimes startling qualities. "Colossal," the overworked Hollywood term, is exactly the word for the Lake View gusher. Drilled in the Sunset field, Kern County, by Lake View Oil Company, the well blew in March 15, 1910 from 2375 ft. Production increased until it was estimated at one time to be flowing about 100,000 bbl daily. The well was running wild and adjoining canyons were dammed to hold the flow. Union Oil Company, which took the well over, estimates a cumulative production in 18 months of 8,308,000 bbl. How much was lost would be hard to judge.



Deepest well in the world is drilled to 17,823 ft. It is the Superior Oil Company's Weller test in Caddo County, Southwestern Oklahoma. Shows of oil were found but not in commercial quantities.

Continental Oil Company came in for a lot of "firsts" when it pushed the A-2 Kern County Land well to 15,004 ft in April, 1938. It was an expensive operation for the time, costing some $281,000, but it pointed the way to cheaper deep drilling and proved that oil can be found below 13,000 ft. Wasco is still one of the good producing fields of great depth and by this time the KCL-2 has balanced its cost with a cumulative production of some half million barrels. It still holds the production depth record for the state.

California's first commercial well is thought by some of the industry's pioneers to have been drilled in Pico Canyon by a Pennsylvanian, Aleck Mentre, in August 1875. There were earlier wells but production was too small for development.

The Summerland field, opened in 1894, was the first to have wells on the ocean tidelands but the first offshore well on an isolated steel pile was drilled by Indian Petroleum Corporation in the Pacific in 1932. The well was in the Rincon field, 2700 ft from shore on a 62-ft pile with a 100 ft derrick.

There are a number of extraordinarily large producers in California with cumulative production running more than 2,000,000 bbl. Potential daily productions today are estimated from a collection of data that for conservation reasons does not allow open flow for testing, so figures are theoretical.

California has a number of wells that have held deep-drilling records. Present state title goes to Pacific Western Oil Corporation's No. 1 National Royalties, a wildcat that was carried to 16,668 ft, deepest hole in the world for 1946. It is situated in Kern County.

Not only did California have the first well drilled below 10,000 ft and 15,000 ft. In the state are also the first one to go below 8000 ft, the first below 9000 ft, below 11,000 ft and below 16,000 ft.

Chanslor-Canfield Midway Oil Company No. 96 Olinda, at Olinda, Orange County, drilled to 8201 ft in April, 1927

to become the deepest well in the world. Shell Oil No. 11 Nesa, Signal Hill, went to 9280 ft in August, 1929 to hold the record until 1930 when Standard of California No. 1 Mascot, Midway, drilled to 9753 ft.

North Kettleman Oil and Gas (now Union) No. 1 Lillis and Welch, Fresno County took the record from the Penn-Mex Jardin well in Mexico by drilling to 10,944 ft in 1933. General Petroleum No. 1 Berry, Kern County, had a total depth of 11,377 ft in May, 1934. Standard of California No. 20-13 Kern County Land drilled to 16,246 ft in December, 1944. All these were record holders of their day.

● **Colorado.** The name of the well that brought in the first field in Colorado is not easily available at this time. The Florence field, one of the oldest in the country and still producing, was discovered in 1862.

Depth record in the state is held by No. 20 Wilson Creek Unit, drilled by California Oil Company and The Texas Company to 12,702 ft in 1945. It has an extremely high elevation of 8204 ft in the Wilson Creek field, Rio Blanco County.

In the same field the operators' No. 10 Unit, completed in 1941, holds the state's record production depth of 7198 ft in the Morrison formation.

● **Florida.** The first commercial oil well in Florida, was the Humble Oil and Refining Company No. 1 Gulf Coast Realties Corporation mentioned before. In the Everglades northwest of Miami, the well went to 11,626 ft and had an initial production of 140 bbl of 20 API gravity oil on pump. The well was completed in September, 1943 and produced almost three years before it was shut in. Florida had to wait for deep drilling to join the oil-producing states. This discovery still holds the state record for production depth.

The largest producer in Florida today is also in Sunniland field on the same Humble lease. Gulf Coast Realties No. 8 in May reached a daily production of 774 bbl of oil after being treated with acid. Initial production in September, 1946 was 527 bbl daily from the Sunniland sand. Total depth is 11,576 ft.

Deepest wildcat, also drilled by Humble, No. 1 L. Treadwell, near Charlotte, Florida, went to 13,300 ft in December, 1945 without production. Deepest hole in Florida is the State of Florida No. 1 Lease 373 well of the Gulf Oil Corporation in Big Pine Key area, 30 miles from Key West. This reached a depth of 15,455 ft and was abandoned April 1, 1947.

● **Georgia.** Although the state has no production, wildcatters have sought oil in Georgia since 1905 when a test was drilled southwest of Louisville, Jefferson County. The operator was Captain A. F. Lucas, famed discoverer of the Texas Spindletop field in 1901. He was not as successful in Georgia and shut down after encountering drilling difficulties at 500 ft. Two years later Georgia Petroleum Company carried it down to crystalline rocks at 1143 ft.

There is an oil well ten miles off the coast of Louisiana in the Gulf of Mexico. Another drilling platform has been constructed 27 miles offshore, four others are in the planning stage within ten miles offshore, with a fifth nearly twenty miles out.

☆ ☆ ☆

In the years since there have been 30 or more wildcats drilled. Some have found gas and oil but not in commercial quantities.

Deepest drilling to be done was at the J. H. Pullen No. 1 well, Mitchell County, 5½ miles east of Pelham. Total depth was 7487 ft.

● **Illinois.** The first successful well for Illinois was discovered in the southwestern part in 1886 but it was not until 1940 that the state got its largest producers. Biggest initial production so far has been 12,000 bbl a day made by Adams Oil and Gas Company No. 17 D Copple in the Centralia pool, Clinton and Marion Counties.

Two wells are important in the part they played in development of the Illinois Basin, both owned by Pure Oil Company. No. 1 Weiler, Clay County, had the first commercial production in the basin. It was completed in February, 1937 in the Cypress sand at 2587-2616 ft for 40 bbl a day. The first large producer in the basin, which attracted national attention, was the No. 1 Travis, Clay County, which came in flowing 2642 bbl a day from the McClosky limestone, topped at 2950 ft.

Drilling has not gone past 7207 ft, a record made by Pure Oil Company No. 3, Billington, Wayne County.

Production depth record is said to be held by Kingwood Oil No. 24-A Shanafelt, Salem field, Marion County, drilled in 1943. It produces from 4657 ft in the Trenton sand.

● **Indiana.** Oil wells spread from Ohio across the line into eastern Indiana in 1886. Fields have always been shallow. Wells in the Griffin pool, Gibson County, hold record production depths around 2900 ft, in McClosky sand. The field was opened in 1938 by Fitzpatrick and Hays No. 1 Cooper, which flowed 604 bbl of oil daily from 2876-87 ft.

Deepest test to date is Continental Oil Company No. 1 Cooper Estate, Gibson County. It was drilled to 6200 ft in 1946.

● **Kansas.** A shallow well near Paola, found oil in 1860 to usher the industry into the state. At the present time Shell Oil Company No. 1 Ridler is said to have the highest potential in the state, more than 50,000 bbl daily. The well is in the Northwest Burnet pool, Ellis County, and produces from the Arbuckle sand from below 3500 ft.

This potential is actually a productivity index, as T. A. Morgan, director of the state conservation division, points out. Possibly the largest producing well ever drilled in Kansas was the Gypsy (now Gulf) Shumway No. 5, Butler County. It was drilled in early 1917 and was estimated to produce initially 25,000 bbl per day. Company officials estimated the well produced an average of 10,000 bbl daily for the first 6 months. It still produces a few barrels per day.

Deepest Kansas production is from Viola lime at 6485 ft. The well, Olson Drilling No. 3 Morrison, Morrison field, Clark County, was completed in 1936 in the Mississipian lime and was abandoned in 1946.

Record depth was made in 1947 by Stanolind Oil and Gas Company No. 1 Feathers, Seward County, with a total depth of 8243 ft. Well was plugged back to 6206 and completed for 4,965,000 cu ft gas.

● **Kentucky.** Drilling for oil in Kentucky followed the Drake discovery but the first commercial well does not appear to be identified. There are tales of a 1000-bbl producer back in 1829 when men were looking for salt.* One of the largest producers in Kentucky is Watt Clements No. 11 of the Carter Oil Company in Uniontown pool, Union County. Initial production was 2600 bbl a day from the Cypress sand. Total depth is 2294 ft.

Columbian Fuel No. 2 Semet-Solvey Coal Company, Pike County, has the deepest production in the state, from the Devonian shale between 3400 and 4500 ft. It was completed in 1942 for 140,000 cu ft of gas. Most of the production was from the shallower depth.

Last year the drill made a state record depth of 6200 ft at California Company No. 1 Spears, Lincoln County.

● **Louisiana.** The marshes of southern Louisiana have the greatest concentration of deep wells in the United States. Last year Shell Oil Company No. 2 Smith-State Unit 1, Week's Island, Iberia Parish, had the deepest production from 13,778 ft. This was followed by a new record made by Shell No. 3 Smith-State, same field, which had an initial production of 502 bbl from as deep as 13,888 ft.

This year The Texas Company No. 1 LaFourche Basin Levee District, Queen Bess Island field, Jefferson Parish, went 16 ft deeper to take the world production depth record according to known data. The well had an initial production of 48 bbl condensate and 6,188,296 cu ft of gas from 13,879-904 ft. Total depth was 15,523 ft.

The same well went to a total of 15,523 ft to take the record drilling depth in the state.

The Texas Company also operated the first well to find production below 10,000 ft. This was the No. 5 Rigoletts in La-Fitte field. It began producing from 10,110 ft in January, 1937. Humble Oil and Refining No. 1 Ellender, Lirette field, Terrebonne Parish, held the record for a time with a production depth of 11,630 in 1937. Three wells in the DeLarge field, Terrebonne, were successive champions: Fohs Oil No. 1 Buckley-Bourg from 13,-

*"This Fascinating Oil Business," Max W. Ball. P. 346.

This world record well in the marshes of southern Louisiana has the deepest production yet discovered. Condensate and gas are produced from 13,879 to 13,904 ft at The Texas Company No. 1 La Fourche Basin Lease District, Jefferson Parish.

266 ft in June, 1938; Union Producing and Fohs Oil No. 1 Fitzpatrick and Vizard from 13,490 ft in June, 1943, and the same two companies' No. 2 Buckley-Bourg from 13,503 in April, 1944.

The first Gulf off-shore well to go below 12,000 ft was Magnolia No. 1 Louisiana Gulf Block 58. It has been plugged. This test was also the first one to be drilled so far from land, 5 miles south of Eugene Island lighthouse.

Magnolia has another well worthy of note in the Gulf of Mexico. This is No. 1 State Lease 684, Block 94, which is about 27 miles south of Marsh Island, Iberia Parish, a location farther from the mainland than any others. The well hit salt at 2610 ft and was temporarily abandoned at 2613 ft in July of this year. The salt is another indication of oil under submerged lands.

The first producer in the Gulf tidelands may be Kerr-McGee Oil Industries No. 1 State Lease 754, Block 32, 10 miles from the nearest land in the Terrebonne Parish. The oil sands are between 1510 ft and 1740 ft, apparently above a shallow salt dome. Water depth is approximately 18 ft.

● **Michigan.** Michigan was quietly ignored by the oil industry for many years and it was not until 1925 that the first well was brought in. The largest initial producer to date appears to be Pure Oil Company No. A 2 W. W. Hoyt, in the Porter field, Midland County, completed November, 1933. The well flowed 21,600 bbl a day from 3408 ft in the Dundee sand. It was plugged and abandoned three years later after producing some 150,000 bbl of oil.

One of the largest cumulative producers in the state is Ohio Oil Company No. 3 Lensby, in the Reed City field, Osceola County. Production has gone over the 200,000-bbl mark. The Lensby was completed February, 1942 in the Monroe sand at 3641 ft.

Record drilling depth in the state was made in 1941 by Gulf Refining No. 1 Bateson, Kawkawlin field, Bay County, which was drilled to 10,447 ft. A projected well will go to 12,000 ft. Deepest production was found by the same well in the Salina sand at 7850 ft.

● **Mississippi.** A newcomer among oil states, Mississippi lured companies with a good state geological survey showing the surface structure on which Tinsley field was discovered in 1939. Union Producing Company No. 1 Woodruff, Yazoo County, opened the field September 5 with an initial production of 255 bbl a day from 4550 ft.

Deepest production sands are found in the Gulf No. 1 L. L. Majors, La Grange field, Jones County. Six zones in the Lower Cretaceous from 12,880 ft to 13,082 ft produced 14 bbl an hour 42 gravity oil on a drillstem test.

A great deal of conjecture has developed over the deepest well, Superior Oil Company No. 1 Cassie Bradford, Forest County, which was drilled tight. It was drilled to 15,730 ft and shut in.

● **Missouri.** So far Missouri has been almost missed by the busy oil industry. It does have producing oil wells but

they are small and shallow. Cities Service Oil Company No. 1 Watkins is probably the largest producer with an initial rate of 31 bbl a day. It is in the Tarkio field, Atchison County, with a total depth of 1401 ft and oil is pumped from the Cherokee sand at about the same depth.

In the same field Cities Service No. 1 Cook has the greatest production depth for Missouri. It is the shallowest well to hold a state depth record. Completed in 1940, the well produces from the Bartlesville sand at 1444 ft, the deepest oil yet found in Missouri.

Strake Petroleum No. 1 Russell, Pemiscot County, has pierced the greatest depth in the state, 4750 ft. It was drilled in 1941.

● **Montana.** In 1915 oil production was found just above the line separating Wyoming from southern Montana. The name of the first well does not seem to be available.

Fulton Oil Company No. 12 Byrne, Kevin-Sunburst field in Toole County near the Canadian border, has the largest initial production so far reported with a daily output of 5000 bbl. The well was completed in April, 1926 and may also have a cumulative production record.

Ten years after the above well was drilled, the deepest production was discovered in Montana-Dakota Utilities No. 1 Unit, Cedar Creek field, Fallon County, in Madison lime at 6767 ft.

Deepest drilling record in the state was made in 1946 when Carter Oil-Phillips Petroleum No. 1 Weazelhead, Milk River area, Glacier County, reached 10,102 ft. The hole was abandoned.

Late information reveals an important new producer which looks like a record breaker. Sinclair Wyoming Oil Company No. 1 U. S. 038541 (Wilkins) Northwest Elk Basin field, had an initial production of 4942 bbl 33 gravity oil. It was completed July 21, 1947, with a total depth of 6795 ft. Production is from Madison lime.

● **Nebraska.** Few persons think of Nebraska as belonging to the list of oil states but it has more than 50 producing wells in Richardson County in the southeastern part of the state.

Deepest production is made by Skelly Oil Company No. 1 Wiltse, Dawson field. This was drilled in 1942 to a depth of 3289 ft and completed at a plugged back depth of 2902 ft for Viola lime production.

Union Oil Company of California drilled the deepest test in 1938 to 6846 ft. It was the No. 15 Agate in Sioux County.

● **New Mexico.** About 1919 shallow production was found in New Mexico but it wasn't until after 1925 that the great southeastern reservoirs were touched. In this section are all the present record wells in the state.

Deepest well is a wildcat drilled by Phillips Petroleum in 1944-45 in Lea County. The No. 4 Lea-Mex went to 13,998 ft in the Pennsylvanian.

A Dublin field well in the same county has the record production depth of 11,928 ft in the Ellenburger sand. This is Humble Oil and Refining No. 1 Leonard-Government, drilled in 1944.

Wilson Oil Company in August of this year brought in a gusher that is rated the largest in the state's history. Potential is estimated at 45,000 bbl a day by Robert Blynn, geologist for Lea County Proration Committee. The well, State 23, in West Eunice pool, is drilled to 3686 ft in lime.

● **New York.** The long history of oil activity in New York, beginning in 1864, has played only a minor role in the national scene but the strategic position close to big markets has kept up the search. This is indicated by the fact that record wells were drilled in recent years.

In 1942 the deepest production was found at 5222 ft by Kane No. 1 Lewis, Steuben County. In 1944 New Penn Development No. 1 Herrington, Steuben County reached the record depth of 8625 ft.

The longest lived well in the state is the Devonian Oil Company No. 1 Triangle, Scio, Allegany County. It has been producing since 1879 and doubtless has a high cumulative output.

New York's famous big well was the Richburg Gusher, which had a first day's production of an estimated 300 bbl on April 27, 1881. Even at that early date it was only substantial production compared to other oil-producing states.

● **North Carolina.** So far North Carolina has had no commercial production but wildcatters have not given up yet. The first test, drilled in 1924-25, was known as the Havelock well, situated on the east shore of Lake Bryan, Craven County. The well was drilled to 2404 ft. At a depth of 2318 ft crystalline rocks were reached. No oil was found.

Last year saw a 10,054-ft well sunk on the great barrier reef off the Atlantic Coast. Standard Oil (New Jersey) No. 1 Hatteras Light, was 30 miles by airline from the nearest point of the mainland. Possibilities of oil were thoroughly tested but no commercial production was found.

● **North Dakota.** With small encouragement to wildcatters, North Dakota has nonetheless had one well drilled below 10,000 ft. This was the California Company No. 1 Kamp, Williams County, which went to 10,281 ft in 1938.

Only production is the 200,000,000 cu ft of gas annual output from the Eagle sandstone at about 1200 ft in the southwestern part of the state where the Baker - Glendive anticline enters the state.

● **Ohio.** Ohio was so close to Pennsylvania in oil development that many Ohioans assert the state was the first oil-producing section of the country. (Kansas sometimes lays claims to this distinction also.)

One of the oldest producers in the United States, the Old Buell, was completed in 1862 or 63, near Macksburg in Washington County, and it continues to produce a fraction of a barrel a day. It was the discovery well of a pool at 508 ft. Production is found at ten times this depth today. East Ohio Gas No. 2 Phillips, Harrison County, produces gas from Clinton sand at 5737-63 ft. It was completed in 1941. Deepest oil production is thought to be at M. B. Belden No. 2 Fry, Stark County. The well pumped 120 bbl the first day after shot from the Clinton sand at 5010-6 ft.

The drill reached 7761 ft in Ohio in 1933. This comparatively old record was made by Penn-Ohio No. 1-C Knowlton in Washington County. It was May 20, 1888, when the well was completed that holds the production record to this day, the T. J. Ducat, in Wood County. At 1200 ft in the Trenton sand the well was estimated to flow 10,000 bbl a day. It was locally owned.

In recent years the largest producer has been Wittmer Oil and Gas Company No. 1 Johnson, Muskingum County. It flowed 500 bbl daily from the Clinton at 3494 ft. Largest well from the Clinton sand was one operated by the Preston Oil Company in Perry County. It produced 627 bbl a day.

● **Oklahoma.** This year Oklahoma celebrated the 50th anniversary of what is called its first commercial well although oil wells appeared in the state six or seven years earlier. Cudahy Oil Company No. 1 Nellie Johnstone discovered oil in Bartlesville, Washington County, in 1897. Production came from a little below 1300 ft at the rate of 50 to 75 bbl daily. Now owned by Cooperative Refinery Association, the well is still producing about one-half barrel a day.

Saudi Arabian drilling activities progress

Seven drilling rigs are operating at present in the Saudi Arabian concession of Arabian American Oil Company. Five of the rigs are run directly by the company and the other two are operated by the Brown Drilling Company.

Wells are being drilled in each of the three oil fields, the major development taking place in the Abqaiq field. Some work is being done in the Baqqa and Qatif fields.

Average production rate from these proven fields ranges from 280,000 to 290,000 bbl a day. The crude is distributed from the main fields to the Ras Tanura refinery, the Bahrein Petroleum Company refinery, and to tankers for offshore shipment. Ras Tanura is processing about 120,000 bbl a day; about 105,000 bbl a day goes in the underground pipe line to the Bahrein Island refinery, and the balance is shipped by tanker to other countries.

In this 50th year of the state oil industry a revival of activity has brought new records. At this date the deepest well in the United States and also in the world is The Superior Oil Company No. 1 Weller, Caddo County, which drilled to 17,823 ft before being plugged and abandoned. A fishing job at 17,236 ft was successfully performed, a record that will probably stand for some years. The well was drilled with regular heavy-duty equipment but no specially built items. Cost was estimated at $1,500,000.

Oklahoma also has the deepest crude oil producer in the world, the Stanolind Oil and Gas Company No. 1 Briscoe Unit, Grady County, which came in last month. On a drillstem test at 13,670 to 13,819 ft, the well made 107 bbl of 48 gravity oil in 5 hours. The deepest producer in the world is The Texas Company well in southern Louisiana, which is a gas and condensate well.

Carter Oil Company has the state record deep pumper, the No. 1 C. W. Mottinger, Washington pool, McClain County. One hundred bbl of oil a day are being pumped from 10,647 ft at present. The well was completed January, 1946. Total depth is 10,682 ft.

In the lush fields of the state are some of the huge producers of the nation. Highest initial producers would probably be found among the wells in the Apache pool. British-American No. 2 Hampton, Oklahoma City field, has one of the most substantial cumulative records, nearly two million barrels. It is still producing about 343 bbl of oil daily with water.

● **Pennsylvania.** Birthplace of modern oil industry, Pennsylvania is filled with many wells that have held "firsts" in their day. It had the first commercial well, the small proud Drake. It has the oldest producer, the McClintock well, drilled on Oil Creek in August 1861 and still producing a fraction of a barrel of oil daily. Initial production from the well was 50 bbl a day from two sands, the deepest around 500 ft. Brundred Oil Corporation now owns the well.

Manufacturer's Light and Heat Company No. 1 Hockenberry, Butler County, holds two records. It is probably the deepest cable-tool test in the world, being drilled to 10.096 ft with cable tools only, and it is Pennsylvania's deepest hole.

The same company owns the well having the deepest oil production, the No. 6 Barton Estate, Summit field, Fayette County. It came in last year from 7495 ft in Onondaga sand.

The deepest producing well is the L. C. Steiner drilled by the Railway Steel Spring Company in Westmoreland County. It had an initial flowing rate of 134,000 cu ft a day from the Oriskany sand at 8010 ft and continues to produce.

Freezeout well on Tionesta Creek brought in the first one-well pool in 1878. It flowed once a week and all tests around it were dry.

The last world depth record held by a Pennsylvania well was made in July, 1925. People's Natural Gas Company No. 1842 Booth and Flynn in Westmoreland County was drilled to 7756 ft, a depth record that was unchallenged for two years. It had also at that time the deepest known producing formation at 7248 ft. Production was gas only.

The first tidelands well to go below 12,000 ft was Magnolia's test in the Gulf, 5 miles from the nearest land in southern Louisiana.

● **South Dakota.** Some gas production has been found in this state recently to encourage prospectors but famous wells are scarce.

Record depth is held by Northern Ordnance No. 1 Harding School Land, Harding County. The well hit 8000 ft in 1943.

● **Tennessee.** Oil was first found in Tennessee in 1866 but production to date remains negligible despite persistent efforts.

Drilling has been shallow, one of the few deeper tests being Sequatchie Gas No. 1 Sewanee Fuel and Iron Company in Grundy County. The well went to 4235 ft in 1932 and had gas production from 2560-5 ft, the deepest known production.

In August, 1947 The California Company No. 1 E. W. Beeler drilled a record 5750 ft depth. Top of granite was 5710 ft. It was a dry hole

Oil has not been found below 1617 ft in the Knox dolomite, just a little below the Missouri production depth record. The Harbor Oil No. 1 Sells, Picket County, was drilled in 1920, which is the oldest for any state record and indicates the somewhat limited drilling in this area. It had an initial production of 50 bbl a day.

The largest initial producer, which made between 750 to 1000 bbl a day, bears a famous name, the Cordell Hull No. 1. The well was drilled by J. H. Overstreet near Selina in Clay County on the Cordell Hull farm. Completed in 1940 production came from 4 depths—481 ft, 503 ft, 555 ft, and 631 ft—a very unusual operation.

Sergeant Alvin C. York, the World War I hero, lends another famous name to a Tennessee well, this time as an operator. In Pickett County he drilled the No. 2 Print Huff to 1700 ft to bring in a commercial producer from the same depth.

● **Texas.** From feeble beginnings of small holes dug for oil in 1867 Texas has become the leading oil-producing section of the world. Emory Starr and Peytone F. Edwards dug those first wells about 15 miles southeast of Nacogdoches, according to the Texas Almanac. The first substantial evidence of its future at the top of oil production did not come, however, until January, 1901 when the famous Lucas well blew in from 1160 ft to open the fabulous Spindletop field in the Gulf Coast area.

The Dad Joiner well, Rusk County, in October, 1930 opened the East Texas field, largest in the world. The Joiner well, a third test drilled at random by the wildcatter, will always remain at the head of the list of Texas' most famous—unless a bigger field than East Texas is found.

Some of the world's largest producers are in the Yates field, Pecos County. Here is the Ohio Oil Company No. 30-A Yates that was completed in September, 1929 with an initial production of 8700 bbl an hour from the Permian lime at 970-1107 ft. Cumulative production has reached some 7,600,000 bbl.

Deepest well in Texas is a wildcat in Brazos County, which went to 16,665 ft, the Lower Cretaceous. It is the Phillips Petroleum No. 3 Fanny Schoeppe.

Other Texas wells that have held drilling depth records are Gulf No. 103 J. T. McElroy, Upton County, which drilled to 12,786 ft in May, 1935, and Texon Oil and Land No. 1-B University, sunk to 8525 ft January, 1929.

Production depth record belongs at present to Placid Oil-Gulf Oil No. 1 Thornberry, Andrews County. This wildcat opened an Ellenburger pool at 11,957 ft and it also holds the record-pumping depth for the United States.

● **Utah.** Oil seepages and large salt domes in Utah are teasers that have never quite paid off. The first production came with the discovery of the Rio Virgin field in the southwestern corner in 1907 but output has been negligible.

Within the last month a new test, Taylor Oil Company No. 1 State, Grand County, in eastern Utah, showed indications of being the first commercial oil well in the state. Casing was being run for completion at 1700 ft.

● **Virginia.** The state of Virginia actually joined the oil-producing states in 1942 when R. Y. Walker brought in the No. 1 B. C. Fugate in the Rose Hill area that reaches over the border from Tennessee. Wells were drilled in Lee County as early as 1910 and some showed promise but no field was proved until the Fugate was completed. Production is small, output at present running about 8 bbl of high gravity oil a day from below 1000 ft.

● **West Virginia.** West Virginia has a long and varied oil history, beginning in 1860, and in 1899 it became the largest oil-producing state in the union. This fame was short. Gas production in this section of the country is very important, however, and drilling continues fairly steadily.

In 1900 what is said to be the largest volume oil well in the state was completed by the South Penn Oil Company on the Michael Copley Heirs lease, Lewis County. Initial production was 10,000 to 12,000 bbl a day from the Gordon sand at 2530 ft.

In Harrison County is the deepest well in the state, Hope Natural Gas No. 8517 Gribble, which was drilled to 10,018 ft in 1941 by rotary. The deepest well drilled by cable tools was the Heinzman No. 4053 by the United Fuel Gas Company, whose total depth was 9104 ft.

National record drilling depths were held in the state in 1918 and 1919, by wells owned by Hope Natural Gas Company. In March, 1918 No. 4190 M. O. Goff, Harrison County, was drilled to 7386 ft and completed as a gas producer from 1749 ft. No. 4304 I. H. Lake, Marion County, went to a total depth of 7579 ft in July, 1919, and apparently held the record for several years. It was a dry hole.

Present producing depth record is held by Ohio Oil Company No. 1 Kuykendall et al, Tucker County, which produces from the Oriskany at 8410 ft. It was drilled in 1946.

● **Wyoming.** "Presence of oil in Wyoming has been known almost since the arrival of the first explorers. Bonneville mentions it in 1832, with actual operations conducted shortly after the Civil War.*

*Pierre LaFleiche, State Mineral Supervisor, in National Scouts and Landsmen's Association Year Book, 1946.

Answers to oil man's test

(Questions on page 48)

1. Huasteca Petroleum No. 4 Cerro Azul in Mexico is estimated to have flowed 300,000 bbl of oil a day; Penn Mex Fuel Company No. 35 Jardin produced 300,000 bbl of 162 F salt water a day.
2. Alabama.
3. Stanolind Oil and Gas Company No. 1 Briscoe Unit, Oklahoma, has the deepest crude oil production; The Texas Company No. 1 LaFourche Basin Levee District, Louisiana, has deepest gas and condensate production, deepest production in the world.
4. Sixteen states have wells that were drilled below 10,000 ft.
5. Alabama, California, Florida, Louisiana, Mississippi, New Mexico, Oklahoma, Texas.
6. Magnolia Petroleum Company No. 1 State Lease 684, Block 94, off the coast of Louisiana.
7. Oklahoma.
8. Arabian-American well in Saudi Arabia, 100 miles from any production.
9. West Virginia.
10. Continental Oil Company No. A-2 Kern County Land well was drilled to 15,004 ft in April, 1938.
11. Production is found as deep as 1400 in Missouri.
12. Florida made the award to Humble Oil and Refining Company. Humble added $10,000 and divided it between two Florida schools.
13. North Dakota and North Carolina.
14. Penn Mex Fuel Company No. 35 Jardin, Mexico.
15. The Texas Company No. 5 Rigoletts, Louisiana.
16. Wyoming.

In the later history of the state the high point was discovery in 1909 of Salt Creek field, one of the major reservoirs in the country.

A surprising well in Wyoming was the Mammoth Oil Company No. 301-A in the Naval Petroleum Reserve No. 3 (Teapot Dome). This well "on October 5, 1922 when drilling at 1520 ft suddenly broke into a crevice from which oil gushed in a solid 12½-in column over the crown block of the 82-ft derrick."†

Perhaps the largest cumulative production record goes to Ohio Oil Company No. 1 Kyle, Medicine Bow field, Carbon County. This well produced from First and Second Sundance sands at 5154 ft and 5299 ft, respectively when it was completed in May, 1935. It has a cumulative production of 1,700,000 bbl of oil and is still producing about 50 bbl of oil a day with water.

The highest hydrogen sulphide content ever found in natural gas is that produced in G. and G. Oil Company No. 1 Well, Neiber field, Washakie County, a discovery in 1947. The well had an initial production of about 900 bbl 42.6 oil and 1,200,000 cu ft gas from the Embar formation at a depth of 10,025-55 ft. Hydrogen sulphide content in the gas is 42 per cent.

Wyoming has some big shallow wells due mention. A well in Lost Soldier field, Sweetwater County, had an initial production of 600 bbl a day from sand topped at 304 ft and one in Osage field had an initial production of 75 bbl a day from shale at a depth of 70 ft.

†Captain H. H. Jalbert, USNR.

Present record drilling and production depths for Wyoming are held by Mountain Fuel Supply Company No. 3 Unit, Uinta County, Church Buttes field. Total depth is 13,063 ft. Production is from Dakota sands between 12,933 ft and 13,050 ft. Initial production was 17,400,000 cu ft of gas with considerable condensate. It was completed in August, 1947.

● **Canada.** Canada's deepest well, said to have cost over a million dollars, is the wildcat drilled by Cities Service and Socony-Vacuum on Prince Edward Island. The No. 1 Hillsborough was completed in September, 1945 after two years of drilling operations. Total depth was 14,696 ft.

An interesting deep well in Canada is that of the Sun Oil Company that was drilled to 11,504 ft in Nova Scotia. H. J. Weeks of Sun says that it is the only one he knows of that drilled through the source material of the salt and into formations below the salt of the salt plug or anticline; however, the test was dry.

● **Ecuador.** The International Ecuadorian Petroleum Company No. 1 Bajada in the southwestern section holds the record in the country for drilling depth, and is said to be the second deepest well in all South America. The drill went to 13,206 ft.

● **Venezuela.** according to available information the deepest well outside the United States is in Venezuela. This is Caribbean Petroleum Company No. 2A Curacao in Zulia, which has drilled to 15,106 ft in September, 1946. ★★★

Hydrocarbon absorption and fractionation process design methods

Part 7. Applications of Sherwood Method

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THE graphical and analytical tools of the Sherwood method were developed and described in the previous installment. In the present chapter, the applications of this method to different types of absorption and stripping problems will be illustrated with step-by-step process design procedures and detailed illustrating examples. The solution of problems is the most effective way of presenting and understanding a process design method.

EXCLUSIVE

In the illustrating examples given in this chapter, two simplifying shortcut assumptions are made: (1) equilibrium constants at average oil temperature are used in constructing the equilibrium lines and also in evaluating the A and S factors, and (2) liquid and vapor quantities at the rich end are used in evaluating the A and S factors. At the rich end of an absorber $\Sigma Y = 1$ and does not appear in equation 70. In all of the absorption and stripping examples that follow, A and S will be found by evaluating equations 70 and 75 at the *rich* end.

TYPES OF DESIGN PROBLEMS

Absorption or stripping process design calculations are made to find one of the following:

(1) Recovery.
(2) Oil-gas (or steam-oil) ratio.
(3) Number of equilibrium stages.

In solving for one of these three unknowns, the other two plus the basic design conditions are fixed, not abritrarily and indescrimently, but with design judgment and with general knowledge of requirements. Design often involves selecting the proper number of plates and the oil-gas (or steam-oil) ratio required for a given desired recovery. In this, economic balances are involved.

Basic conditions for absorber design that may be assumed to be given or determined by operating requirements are:

(a) Wet gas composition.
(b) Lean oil quality.
(c) Relative volatility (and recovery) of different wet gas components.
(d) Operating pressure.
(e) Temperatures of lean oil and wet gas.

The composition of the wet gas to the absorber is usually given, except where there is gas recycling involved in the recovery, in which case the wet gas charge to the absorber is the sum of the net gas charge and the recycle.

The lean oil quality is usually fixed by the basis of design although some design problems involve evaluating different solvents, such as heavy naphtha, kerosene, gas oil, etc. Accordingly, the physical properties of the solvent used in the process design calculations will be those for the given lean oil or alternates. For the purpose of process design the solvent quality will be considered as a fixed basis rather than a variable.

For any given operating conditions and desired key component recovery, the recoveries of all the other components in the solute are fixed and invariant. It may not be easy to compute accurately the recoveries of the different components but once the system characteristics are established so are the recoveries of all components. This is true for the absorber or stripper of theoretical equilibrium plates because the relative recoveries of the various hydrocarbons are a function of and approximately proportional to the relative volatilities of the hydrocarbons. The relative volatilities of hydrocarbons are, to a certain extent, dependent upon the pressure and temperature conditions and also upon the characteristics of the solvent oil.

Other factors effecting relative recoveries between absorption and stripping processes are the oil-gas ratio and the number of stages. Although it is not possible to state that the relative recoveries of any two hydrocarbons will always be fixed, it is convenient to think of the relative recoveries as being fixed by the given design basis. This will be demonstrated later in the examples.

The operating pressure is given as a basic condition yet it may be varied depending upon the nature of the problem. Within practical limits most any pressure may be selected for absorption or stripping operating and the facilities designed accordingly. To a certain extent, the proper pressure to use depends upon economics, which includes cost of equipment, operating cost, and realizations on the recovered products. In general, it can be said that higher recovery of light components must be obtained by increasing the operating pressure of the absorber as well as using a high quantity absorption oil. Sometimes the cost of compressing the gas to a high pressure is prohibitive and the desired recovery is obtained by recycling gas and by using a large quantity of lean oil.

In the stripper the operating pressure is determined by the composition of the recovered product, it being necessary to operate at a sufficiently high pressure to permit condensing the hydrocarbon product being stripped from the oil. Although operating pressure is listed as a design basis, it is frequently the objective of process design investigation.

The temperatures of the lean oil and the wet gas may be considered as basic conditions because they depend upon heat exchange and cooling facilities and are substantially independent of the absorption or stripping process operations. Frequently it is necessary to have intercoolers in the absorber to cool the oil as it passes down the column. This is necessary where the heat of absorption is significantly large as it might be with a rich gas and/or a moderate or low quantity of lean oil. The temperature in a stripper is a function of the operating pressure when steam is the stripping medium and is found from the steam tables as the temperature of saturated steam at the tower pressure.

DESIGN CALCULATION PROCEDURES AND ILLUSTRATIONS

In almost all hydrocarbon absorption and stripping design problems, the curvature of the equilibrium line is not appreciable so that the equilibrium lines may be constructed with sufficient accuracy if the slope at the origin and the location at a point on the rich end are known. This is done by fitting to this origin slope and the rich end point a regular French or Ship Curve. The location of an equilibrium line is determined by the total *absorbings* or *strippings*, which quantities are dependent upon the equilibrium relations. Consequently, successive approximations are necessary although it is possible to reduce the amount of work by using the best technique.

In the following outlines of calculation procedures, absorption and stripping will be treated separately and under each, three types of problems will be covered. These three types will be identified by the three unknowns as listed at the beginning of this chapter which are (1) recovery for given number of stages and oil-gas ratio; (2) oil-gas ratio for desired recovery with given number of stages; (3) number of equilibrium stages and lean oil rate for desired recovery. Equations and graphs appearing in the previous chapter are referred to in these calculations.

Absorption calculations. The step-by-step procedures for three types of problems are listed below. It is assumed that temperatures and pressures are known and do not vary appreciably. It is also

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assumed that the quantity and composition of the wet gas are given. Examples illustrating each procedure will be presented with the step-by-step statement of the procedure.

In the following design procedures and examples, no attention will be given the checking of the assumed average temperatures used in making the absorption calculations. It is good practice to check these temperatures by means of a heat balance after the absorption has been estimated. Temperature corrections would be made differently for the Sherwood method than other methods because absorption factors in the Sherwood method are estimated with an average temperature and an L/V ratio that is corrected for the amounts absorbed, giving the effective absorption factor. In the Horton-Franklin and the Edmister methods, the effective absorption factors are estimated from the values at the top and bottom.

Type I procedure: "Find recovery in an absorber with a given number of equilibrium stages and oil-gas rate."

Step (1). Find equilibrium constants, K, at the average oil temperature and the pressure of the column, for each of the constituents.

Step (2). Compute L/KV for each constituent.

Step (3). Estimate fraction of each constituent absorbed from equation (71) or Fig. 28, neglecting the ΣX term.

Step (4). Compute ΣX from the first estimate of absorption and then compute

$$\frac{L(1+\Sigma X)}{KV}$$

for each constituent.

Step (5). With this new value of absorption factor, again compute amounts of each constituent absorbed from equation (71) or Fig. 28, this time including the ΣX term.

Step (6). Construct the equilibrium curve for the key component from the slope at the origin as $K(\Sigma Y_L)$ and a point on the rich end by getting X in equilibrium with Y_R by equation (66).

Step (7). Construct the operating line, which has a slope of L_o/V_{n+1} and is fixed by trial so the correct number of theoretical plates will be stepped off between the operating and equilibrium lines.

Step 8. The intersection of the operating line and the Y axis gives the composition of the key component in the exit gas. If this absorption of the key component checks the amount found by Step 5, the absorptions found by Step 5 are correct. If not, Step 5 should be repeated with an adjusted ΣX, which is another way of saying an adjusted

$$\frac{L(1+\Sigma X)}{KV}$$

The Type I procedure outlined above is illustrated by the following example:

Example 12. A 30-plate absorber operates at 60 psig treating 18,000,000 std cu ft (atm and 60 F) per 24 hr, of a gas containing 83 per cent methane, 8.4 per cent ethane, 4.8 per cent propane, 0.9 per cent isobutane, 1.7 per cent n-butane, 0.4 per cent isopentane, and 0.8 per cent n-pentane. The tower will be supplied with 300,000 gal. per 24 hr of a denuded oil having a gravity of 40° API (sp. gravity = 0.8251) and an average molecular weight of 161. The tower will operate with an average oil temperature of 90 F. Assume an overall plate efficiency of 20 per cent. Find the recovery of each component in the wet gas.

Solution. $30 \times 0.20 = 6$ theoretical plates.

$$\text{Inlet gas} = V_{n+1} = \frac{18{,}000{,}000}{359} \times \frac{492}{520} \times \frac{1}{24} = 1975 \text{ lb mols/hr.}$$

$$\text{Inlet oil} = L_o = 300{,}000 \times \frac{8.33 \times 0.8251}{161} \times \frac{1}{24} = 534.0 \text{ lb mols/hr.}$$

$$\frac{L_o}{V_{n+1}} = \frac{534}{1975} = 0.2705$$

The calculations for Steps 1, 2, and 3 are given in Table 15.

The calculations for Steps 4 and 5 use the following equations:

$$\frac{L(1+\Sigma X)}{V} = \frac{534(1+68.52)}{1975} = 0.3055$$

Steps 4 and 5 calculations are given in Table 16.

As the total absorption by Step 5 checks that by Step 3 closely (75.59 vs. 68.52), a more careful treatment of the key component may now be made. The key component is i-pentane, because the value of $\frac{L(1+\Sigma X)}{KV}$ for it is closer to unity than for the other components.

TABLE 15. Calculations for Steps 1, 2 and 3 of Example 12.

Component	Y_R	Mols/hr in	$K_{75\text{-lb.}}^{90°}$	$A = \frac{L}{KV}$	Fraction absorbed	Mols/hr absorbed	X_R	Off gas, mols/hr	Y_L
Methane	0.830	1639.2	42.5	0.00635	0.00635	10.42	0.0195	1628.78	0.826
Ethane	0.084	165.8	7.3	0.0370	0.037	6.14	0.01146	159.66	0.081
Propane	0.048	94.9	2.25	0.1200	0.120	11.40	0.02135	83.50	0.0423
i-Butane	0.009	17.8	0.88	0.307	0.307	5.46	0.01022	12.34	0.00625
n-Butane	0.017	33.6	0.65	0.415	0.415	13.95	0.02610	19.65	0.00995
i-Pentane	0.004	7.9	0.28	0.965	0.836	6.60	0.01237	1.30	0.000659
n-Pentane	0.008	15.8	0.225	1.200	0.920	14.55	0.02725	1.23	0.000623
	1.000	1975.0				68.52		1906.46	

TABLE 16. Calculations for Steps 4 and 5 of Example 12.

Component	$A = \frac{L(1+\Sigma X)}{KV}$	Absorption efficiency	Mols/hr absorbed	Off gas, mols/hr	Y_L
Methane	0.00718	0.00718	11.76	1627.44	0.8240
Ethane	0.04185	0.04185	6.93	158.87	0.0805
Propane	0.1358	0.1358	12.88	82.02	0.0416
i-Butane	0.3470	0.3470	6.18	11.62	0.00590
n-Butane	0.470	0.470	15.80	17.80	0.00902
i-Pentane	1.090	0.89	7.03	0.87	0.00044
n-Pentane	1.358	0.95	15.01	0.79	0.00040
			75.59		0.96186

Step 6. The slope of the equilibrium curve at the origin is

$$K(\Sigma Y_L) = (0.28)\ (0.96186) = 0.269.$$

The value of X in equilibrium with $Y_R = 0.004$ is obtained by using equation (66) as follows:

$$X = \frac{Y_R(1+\Sigma X_R)}{K(\Sigma Y_R)} = \frac{0.004\left(1+\frac{75.59}{534}\right)}{(0.28)\ (1.0)} = 0.161$$

This locates one point on the equilibrium curve near the rich end of the column, as shown by point A on Fig. 33. The equilibrium curve is drawn in its approximate position, starting at the origin with a slope of 0.269 and curving off to pass through point A.

The slope of the operating line is $L/V = 534/1975 = 0.2705$. A straight line with this slope is placed by trial at a location such that six steps (corresponding to six theoretical plates) can be stepped off between operating and equilibrium lines. The value of Y for isopentane, which corresponds to its content in the residue gas leaving the column is read to be 0.00048. The mols of isopentane absorbed are consequently (0.004—0.00048) 1975=6.95 vs. 6.6 estimated by Step 3 and 7.02 estimated by Step 5, which is close enough. If absorption of key component had been much different, another calculation would have been necessary to adjust total absorption.

Type II procedure. "Find the oil rate for a desired recovery in an absorber with a given number of equilibrium stages."

Step (1). From Fig 28 find $\frac{L(1+\Sigma X)}{KV}$ necessary for the desired recovery of the constituent in question. Construct XY diagram for key component.

Step (2). With this value of absorption factor, find the recovery of the other constituents.

Step (3). Compute the oil rate, L_o and convert to gallons.

The above Type II procedure is illustrated by the following example:

Example 13. Find the oil rate necessary in Example 12 to absorb 80 per cent of the n-butane. Find also the amounts of other components absorbed and the composition of the exit gas.

Step 1. For 6 theoretical plates and an E_a value of 0.80 the value of $\frac{L(1+\Sigma X)}{KV}$ is found to be 0.9.

Multiplying by the K for n-Butane gives

$$\frac{L(1+\Sigma X)}{V} = 0.9 \times 0.65 = 0.585.$$

Multiplying by V_{n+1} gives $L(1+\Sigma X) = 0.585 \times 1975 = 1155$ mols/hr.

Step 2. The calculations for this step are given in Table 17.

Step 3. $L_o = 1155 - 122.53 = 1032.47$ mols/hr solvent.

$$1032.47 \times 24 \times \frac{161}{8.33 \times 0.825}$$

$= 582{,}00$ gal oil per day.

This type of problem is simpler than Type I so the graph is omitted.

The third unknown listed under "Types of Design Problems" is the number of equilibrium stages for a given oil rate and desired recovery. This is a straight forward problem involving the preparation of an XY graph followed by constructing the required number of steps between the operating and equilibrium lines. No successive approximations are necessary. The procedure is a combination of Types I and II above.

A more interesting problem is to find the lean oil rate and the number of equilibrium stages. This involves making several solutions and selecting the most practical or economical one. The procedure for this design problem is outlined below as Type III.

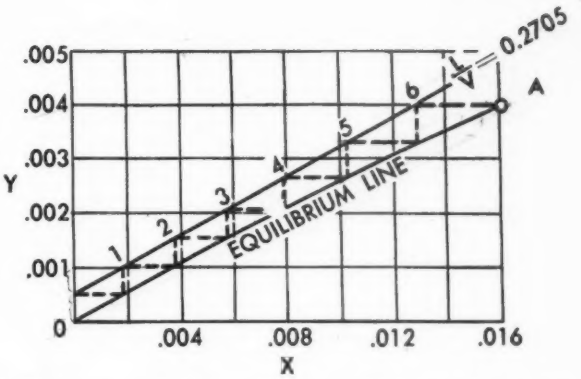


FIG. 33. XY diagram for i-pentane in Example 12 illustrating Type I.

Type III procedure. "Find the lean oil rate and the number of theoretical equilibrium plates for desired recovery."

Step (1). Find K constants for each constituent at the given temperature and pressure.

Step (2). Estimate absorption by equation (73) and compute Y_L for the key component, and then find ΣX.

Step (3). Find minimum lean oil-wet gas ratio by trial with equation (74).

Knowing the minimum L/V ratio, assume or estimate a higher ratio for further calculations.

Step (4). Plot equilibrium line for key component as in Step 6 of Type I.

Step (5). Using an L_o/V_{n+1} ratio higher than the minimum reflux ratio as slope of the operating line and Y_L from Step 2, draw the operating line.

Step (6). Find number of theoretical plates by the stepwise method. If number found is too large to be reasonable, repeat with a higher L_o/V_{n+1} ratio.

Step (7). Using the L_o/V_{n+1} ratio decided upon in Step 6 and assuming ΣX, compute $\frac{L(1+\Sigma X)}{KV}$ for each component and get amounts absorbed by means of equation (71) and Fig. 28. Computed ΣX should check Assumed ΣX; if not, repeat Step 7.

Step (8). Absorption of key component by Step 7 should check desired absorption. If not, repeat 4, 5, 6 and 7 with adjusted ΣX.

The Type III procedure outlined above is illustrated by the following example:

Example 14. Design an absorber to recover 80 per cent of the n-butane in Examples 12 and 13.

Steps 1 and 2. Estimate absorption of other components relative to absorption of n-butane by equation (73).

The calculation for steps 1 and 2 are given in Table 18.

Step 3. Find minimum reflux ratio by trial from equation (74), assuming values of L and calculating L_o/V_{n+1} and $\frac{KE_a}{1+\Sigma X}$ until an L_o/V_{n+1} ratio is found that satisfies equation (74).

In this calculation:

$$\Sigma X = \frac{115.7}{L_o}$$

Assumed L	L/V	$\frac{KE_a}{1+\Sigma X}$
1000	0.506	0.466
900	0.456	0.461

For the minimum reflux ratio an infinite number of theoretical plates will be required. Assume a higher reflux ratio and find the number of theoretical plates.

Assume $L_o/V_{n+1} = 0.50$, $L_o = 0.50 \times 1975 = 990$

Step 4. Plot equilibrium line for n-butane and find number of theoretical plates.

Slope of the equilibrium line at origin.

$$K(\Sigma Y_L) = 0.65\left(1 - \frac{115.70}{1975}\right) = 0.622.$$

The value of X in equilibrium with $Y_R = 0.017$.

$$X(\text{equilibrium}) = \frac{0.017}{0.65}\left(1 + \frac{115.7}{990}\right) = 0.0303.$$

Steps 5 and 6. Slope of operating line $= 0.50$.

$Y_L = 0.0034$ = intersection on $X = 0$—axis.

Fig. 34 shows a plot of equilibrium and operating lines for this example. With reflux ratio of 0.50 approximately

TABLE 17. Calculations for Step 2 of Example 13.

Component	Y_R	V_R inlet gas, mols/hr	$K_{75\text{-lb.}}^{90°}$	$\frac{L(1+\Sigma X)}{KV}$	Absorption		Off gas, mols/hr
					Fraction	Mols/hr	
Methane	0.830	1639.2	42.5	0.01378	0.01378	22.60	1616.6
Ethane	0.084	165.8	7.3	0.0801	0.0801	13.28	152.52
Propane	0.048	94.9	2.25	0.260	0.260	24.67	70.23
i-Butane	0.009	17.8	0.88	0.665	0.638	11.38	6.42
n-Butane	0.017	33.6	0.65	0.90	0.80	26.9	6.7
i-Pentane	0.004	7.9	0.28	2.09	1.0	7.9	0
n-Pentane	0.008	15.8	0.225	2.60	1.0	15.8	0
	1.000	1975.0				122.53	1852.47

TABLE 18. Calculations for Steps 1 and 2 of Example 14.

Component	Y_R	Mols/hr in	$K_{75\text{-lb}}^{90°}$	Absorption		Mols/hr out	Y_L
				Fraction	Mols/hr		
Methane	0.830	1639.2	42.5	0.01225	20.70		
Ethane	0.084	165.8	7.3	0.0712	11.80		
Propane	0.048	94.9	2.25	0.231	21.95		
i-Butane	0.009	17.8	0.88	0.598	10.65		
n-Butane	0.017	33.6	0.65	0.80	26.90	6.7	0.0034
i-Pentane	0.004	7.9	0.28	1.00	7.9		
n-Pentane	0.008	15 8	0.225	1.00	15.8		
	1.000	1975.0			115.70		

9 perfect plates are required, while for a reflux ratio of 0.60 approximately 4½ perfect plates are required.

The optimum choice of column size and oil-gas ratio depends upon the equipment (absorber, stripper, and auxiliaries) cost and the processing (oil pumping, and stripping, etc.) cost.

Step 7. Compute absorption of all constituents for nine theoretical plates and $L/V = 0.50$.

From experience and/or other trials, it is evident that the total absorption will be higher than the 115.7 mols found above.

Assume total mols absorbed = 122 mols/hr, giving $\frac{L(1+\Sigma X)}{V} = 0.561$

See Table 19 for these calculations.

Step 8. This step shows 82.5 per cent of the n-butane absorbed as against 80 per cent desired. Repeat Steps 4, 5, and 6 using 120 mols/hr absorbed instead of 115.7 to get number of theoretical plates and reflux ratio. Then repeat Step 7 to get the total absorption.

This involves making a new XY graph.

This example may be compared with Example 13 where an 80 per cent recovery of n-C_4 was obtained with six theoretical plates and 1032.47 mols/hr of lean oil as compared with nine theoretical plates and 990 mols/hr of lean oil for this example.

Stripping calculations. The step-by-step procedures for three types of stripping process design calculations are listed below. As in the case of absorption, it is assumed that temperatures and pressures are known and do not vary appreciably and that an average temperature may be used. Likewise it is assumed that the quantity and composition of the rich oil are known. Illustrating examples follow the step-by-step procedures.

Type I Procedure. "Find recovery of condensibles from a given amount and composition of rich oil and given number of equilibrium stages and a given stream rate.

Step (1). From steam tables find temperature of saturated steam at the given operating pressure. This may be assumed to be the average temperature.

Step (2). Find equilibrium constants, K, at the average operating pressure and temperature of the column for each constituent to be stripped from the rich oil. Compute KV_o/L_o for each component.

Step (3). Estimate fraction of each constituent stripped by using equation (76) or Fig. 28 neglecting ΣX and ΣY terms and then compute the mols of each stripped.

Step (4). Compute ΣX and ΣY from first estimate of stripping and then compute $\frac{KV_o(1+\Sigma Y)}{L_o(1+\Sigma X)}$ for each constituent.

Step (5). With these new values of stripping factors compute amounts of each constituent stripped from equation (76) or Fig 28.

Step (6). Construct the equilibrium curve for the key component from the slope at the origin as K and a point on the rich end by getting Y in equilibrium with X_R from Equation 69.

TABLE 19. Calculations for Step 7 of Example 14.

Component	Mols/hr in	$\frac{L(1+\Sigma X)}{KV}$	Absorption	
			Fraction	Mols
Methane	1639.2	0.01328	0.01328	22.45
Ethane	165.8	0.0772	0.0772	12.8
Propane	94.9	0.2505	0.2505	23.8
i-Butane	17.8	0.641	0.640	11.4
n-Butane	33.6	0.867	0.825	27.7
i-Pentane	7.9	2.015	1.0	7.9
n-Pentane	15.8	2.505	1.0	15.8
	1975.0			121.85*

*Check 122 assumed.

TABLE 20. Calculations for Steps 2 and 3 of Example 15.

Component	Mols/hr in, rich oil	$K^{358°}_{150\text{-lb.}}$	KV_o/L_o	E_s	Mols/hr stripped
Methane	11.76	59	27.6	1.0	11.76
Ethane	6.93	19	8.9	1.0	6.93
Propane	12.88	9	4.22	1.0	12.88
i-Butane	6.18	5	2.34	1.0	6.18
n-Butane	15.80	4	1.87	0.99	15.64
i-Pentane	7.03	2.5	1.14	0.90	6.32
n-Pentane	15.01	2.2	1.03	0.86	12.91
	75.59				72.62

Step (7). The slope of the operating line is L_o/V_o and its location is determined by trial so the correct number of theoretical plates may be stepped off between the operating and equilibrium lines.

Step (8). The intersection of the operating line and the X axis gives the composition of the key component in the exit lean oil. From this, the amount stripped can be computed. If this checks the previously computed amount of key component stripped, the previous estimates (Step 3 or 5) for the amounts of other components stripped are correct. If not, Step (5) should be repeated with an adjusted stripping factor to get the corrected amounts of each component stripped from the rich oil.

The Type I stripping procedure will be illustrated by the following example:

Example 15: Find the recovery of each solute component by stripping the rich oil from Example 12 with 4500 lb/hr of steam in a 24-plate stripper operating at 135 psig (150 psia). Assume an overall plate efficiency of 25 per cent.

Solution. $24 \times 0.25 = 6$ theoretical plates

Steam $= V_o = 4500/18 = 250$ lb mols/hr.

Lean oil $= L_o = 534$ lb mols/hr.

$\frac{V_o}{L_o} = 250/534 = 0.468$

Step 1. Steam at 150 lb must be used, thus giving at temperature 358 F from Steam Tables.

Steps 2 and 3. The calculations for these steps are given in Table 20.

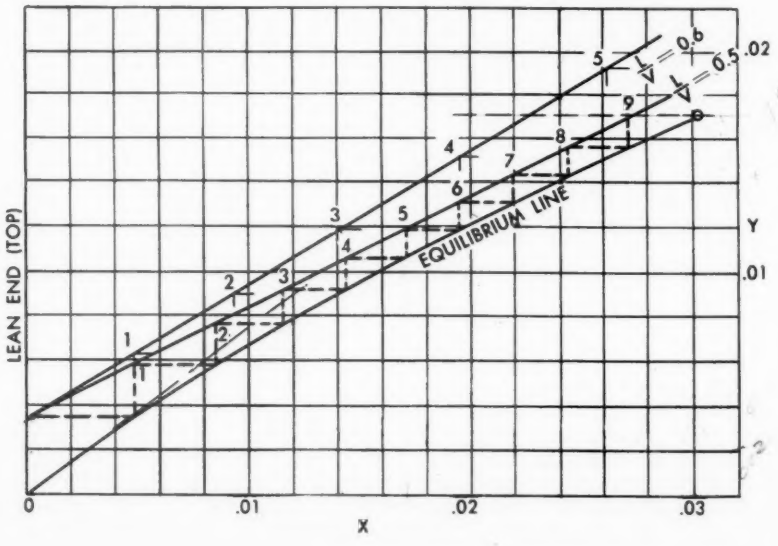
Steps 4 and 5: $\Sigma X = 75.59/534 = 0.142$; $\Sigma Y = 72.62/250 = 0.2905$.

$\frac{V_o}{L_o}\frac{(1+\Sigma Y)}{(1+\Sigma X)} = \frac{250}{534}\frac{(1.2905)}{(1.142)} = 0.530$

Calculation of absorption is given in tabulation that follows.

As the total stripped by Step 5 checks that by Step 3 closely (73.69 vs. 72.62), a more careful treatment of the key

FIG. 34. XY diagram for n-butane in Example 14 illustrating Type III absorber calculations.



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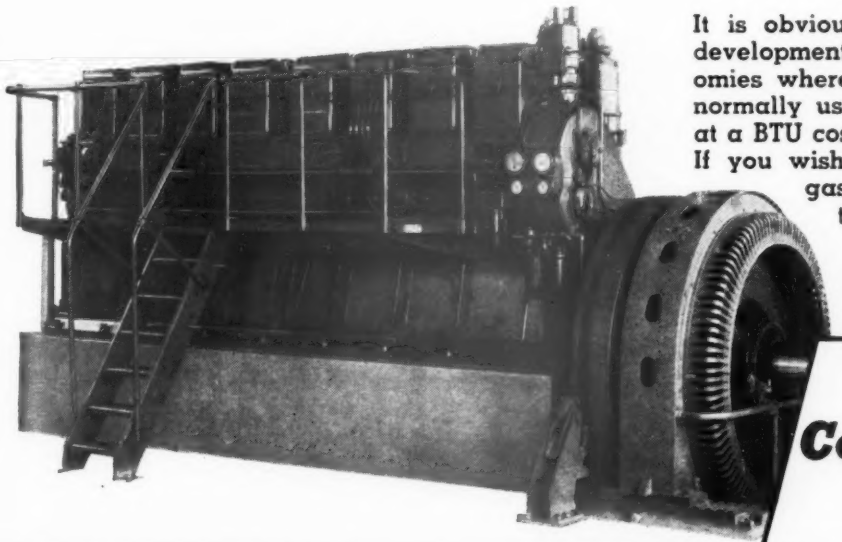
TOTAL BTU/BHP/HR

ENGINE TYPE	100% load	75% load	50% load	25% load
Spark-ignited gas engine	9,500	10,000	12,000	17,800
Supercharged oil Diesel	7,400	7,450	7,950	9,250
Supercharged gas-Diesel (ordinary)	7,200	8,600	12,000	20,500
C-B supercharged gas-Diesel (new)	6,400	6,750	7,350	8,950



It is obvious from the chart that this recent development opens the way to important economies wherever spark-ignited gas engines are normally used, wherever gas fuel is available at a BTU cost even approaching that of fuel oil. If you wish to investigate the application of gas-Diesels for your particular conditions and needs, the nearest Cooper-Bessemer office will gladly give you full cooperation.

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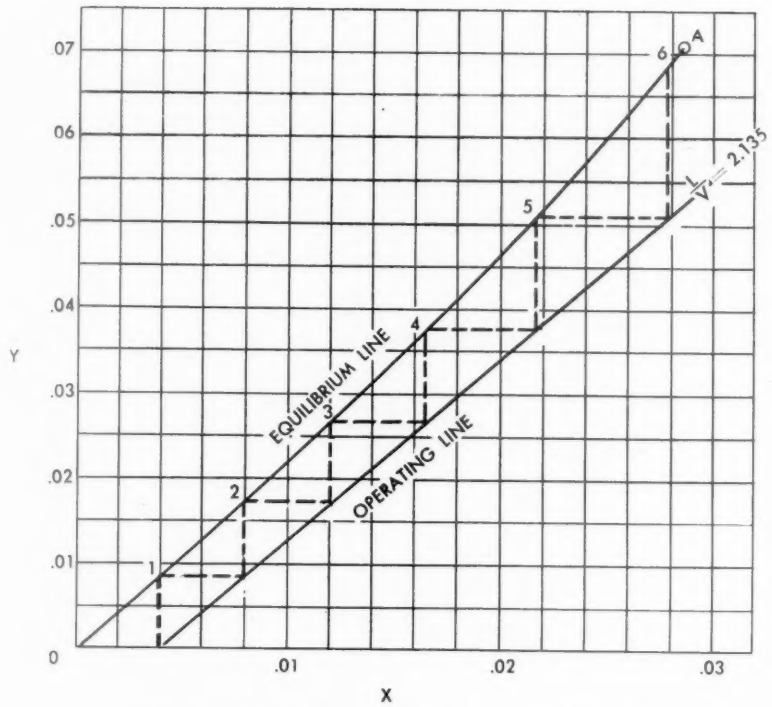

FIG. 35. XY diagram for n-pentane in Example 15 illustrating Type I stripper calculations.

Component	$S=\frac{KV_0(1+\Sigma Y)}{L_0(1+\Sigma X)}$	E_s	Mols/hr stripped
Methane	31.28	1.0	11.76
Ethane	10.07	1.0	6.93
Propane	4.77	1.0	12.88
i-Butane	2.65	1.0	6.18
n-Butane	2.12	1.0	15.64
i-Pentane	1.325	0.94	6.61
n-Pentane	1.165	0.91	13.69
			73.69

component will now be made. The key component is n-pentane.

Step 6. The slope of the equilibrium curve at the origin is K = 2.2.

At top of column, X = 15.01/534 = 0.0282, and

Y (by Equation 69) $= 2.2 \times 0.282 \frac{(1+73.69/250)}{(1+75.59/534)} = 0.0703$

This locates one point on the equilibrium curve near the rich end of column, as shown by point "A" on Fig. 35. The equilibrium curve is drawn in its approximate position, starting at the origin with a slope of 2.2 and curving off to pass through point "A".

Step 7. The slope of the operating line is $L_o/V_o = 534/250 = 2.135$. A straight line with this slope is placed below the equilibrium curve by trial in a position such that six steps corresponding to six theoretical plates can be stepped off between operating and equilibrium lines.

Step 8. The n-pentane content of the lean oil leaving the bottom of the column is 0.00385 mols/mol of lean oil. The mols of n-pentane stripped is consequently (0.0282—0.00385) 534=13.00 vs. 12.91 estimated by Step 3 and 13.69 by Step 5.

Repeat Step 5. By Step 8, $E_s = 13.00/15.01 = 0.865$ for n-pentane, for which $KV_o/L_o = 1.04$ from Fig. 28.

$V_o/L_o = \frac{KV_o/L_o}{K} = 1.04/2.2 = 0.4725$

With this value of KV_o/L_o for n-pentane, the KV_o/L_o values for the three heaviest components are computed and the stripping efficiencies estimated as shown below.

	KVo/Lo	Es	Mols/hr stripped
nC_4	1.89	0.99	15.65
iC_5	1.18	0.912	6.41
nC_5	1.04	0.865	13.00

The lighter components are stripped completely, the amounts being given in the previous steps.

Type II Procedure: "Find the stripping steam rate for a desired recovery in a stripper with a given number of equilibrium stages."

Step (1). From Fig. 28 find value of $\frac{KV_o(1+\Sigma Y)}{L_o(1+\Sigma X)}$ necessary for the desired recovery of the constituents in question.

Step (2). From this stripping factor compute the stripping factor for other constituents, find the stripping efficiency, and compute the recovery of the other components.

Step (3). Compute the steam rate, V_o, and convert to pounds per hour.

The above Type II procedure is illustrated by the following example:

Example 16. Find steam rate necessary in Example 15 to strip 98 per cent of n-pentane from the rich oil. Find also the amounts of other components stripped.

Step 1. Using Fig. 28, the required corrected stripping factor for an E_s of 0.98 for n-C_5 is found for six theoretical plates.

$\frac{KV_o}{L_o}\frac{(1+\Sigma Y)}{(1+\Sigma X)} = 1.75$, for $E_s = .98$ (for n-C_5)

$\frac{V_o}{L_o}\frac{(1+\Sigma Y)}{(1+\Sigma X)} = 1.75/2.2 = 0.795$

See Table 21 for these calculations.

Step 2.

Step 3. Knowing the required value of $\frac{V_o(1+\Sigma Y)}{L_o(1+\Sigma X)}$ and the quantities stripped, find the stripping steam rate.

$V_o\frac{(1+\Sigma Y)}{(1+\Sigma X)} = 0.795 \times 534 = 422$ mols/hr.

$V_o = 422\frac{(1+\Sigma X)}{(1+\Sigma Y)} = 422\frac{(1+75.59/534)}{(1+75.22/V_o)}$

$V_o + 75.23 = 482$

$V_o = 482 - 75.23 = 406.77$ mols/hr steam.

$406.77 \times 18 = 7{,}315$ lbs/hr steam

Type III procedure: "Design a stripper (i.e. find stream rate and number of plates) for a desired recovery of key component."

Step (1). Find operating pressure at which most of the recovered hydrocarbons may be condensed with cooling water available. (*Note:* From the condenser, the stripped hydrocarbons usually go to a stabilizer feed tank, from which suction may be taken by stabilizer feed pump. Some of the lighter hydrocarbons will not be condensed and will be vented off the top of this feed tank back to the absorber where they will be reabsorbed. These facts must be considered in design).

Step (2). Find K constants for each constituent at the given temperature and

TABLE 21. Calculations for Step 2 of Example 16.

Component	Mols/hr in rich oil	$K^{358°}_{150\text{-lb}}$	$\frac{KV_o(1+\Sigma Y)}{L_o(1+\Sigma K)}$	Stripping	
				Es	Mols/hr
Methane	11.76	59	46.9	1.0	11.76
Ethane	6.93	19	15.1	1.0	6.93
Propane	12.88	9	7.16	1.0	12.88
i-Butane	6.18	5	3.98	1.0	6.18
n-Butane	15.80	4	3.18	1.0	15.80
i-Pentane	7.03	2.5	1.99	0.99	6.95
n-Pentane	15.01	2.2	1.75	0.98	14.73
	75.59				75.22

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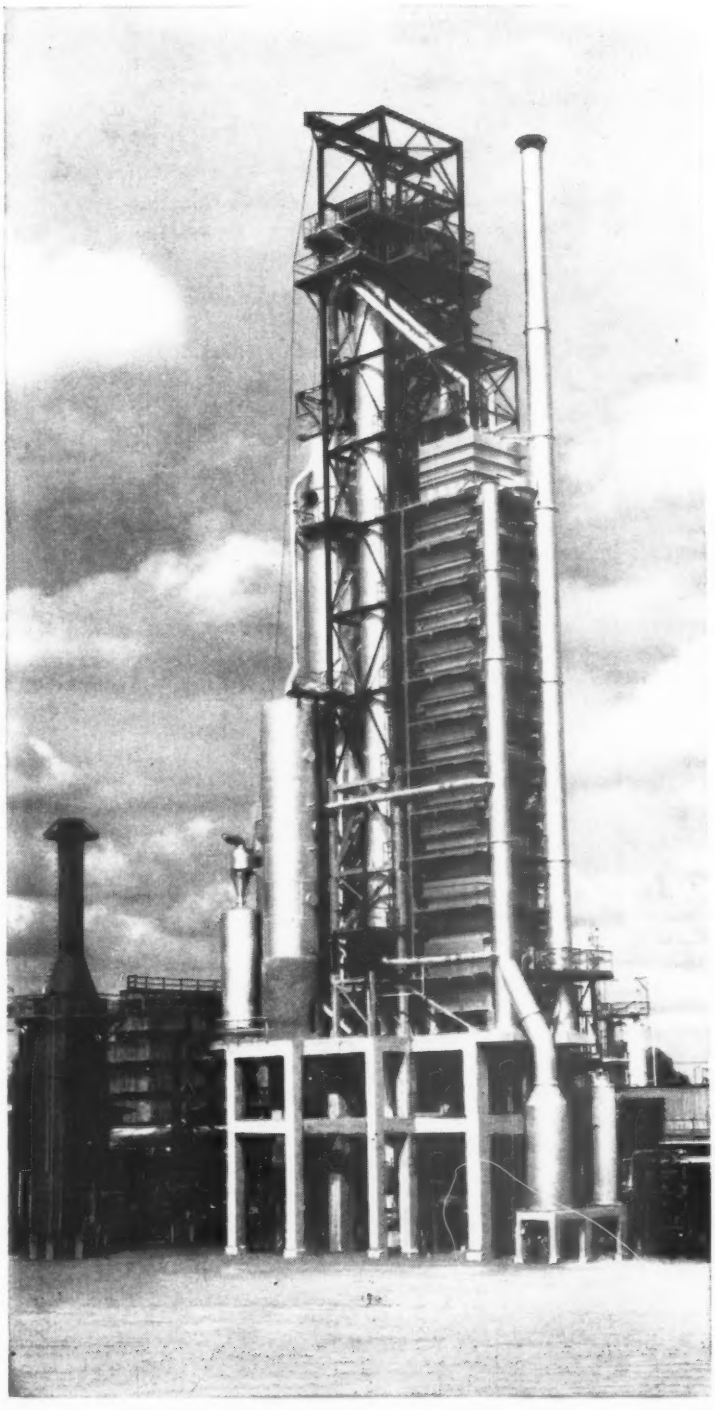

On September 16, the sixty-seventh Houdry-licensed cat cracker—and the thirty-eighth T C C—went on stream in the refinery of Lion Oil Company at El Dorado, Arkansas. This unit is of 4,500 bbl. fresh feed capacity, with 900 bbls. additional capacity for recycling.

This new Lion unit will process high-sulfur crude (1.8% in the reactor charge). Corrosion protection is provided by lining the reactor, fractionating tower and all vessels with alloyed steel.

In actual operation, this new T C C unit is running 20% over design capacity, enabling Lion to maintain the high octane quality of its motor gasoline output at considerably reduced costs. And, with built-in recycling, the refiner will be able to vary his product distribution at will, according to seasonal demands.

These are advantages inherent in T C C which have made it the catalytic cracking process outstandingly favored by refineries of relatively moderate size. Details will be furnished gladly to interested refiners.

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pressure and estimate stripping of other components by equation from the stripping of key component. Compute X_L for key component.

Step (3). Find minimum steam-lean oil ratio by trial from equation (79).

Step (4). Plot equilibrium curve for key component as in Step (6), Type I.

Step (5). Using V_o/L_o ratio higher than the minimum to get the slope of the operating line and X_L as the intersection with the Y = 0 axis, the operating line is drawn.

Step (6). Find number of theoretical plates by the stepwise method. If number found is too large to be reasonable, repeat with a higher V_o/L_o ratio or lower slope.

Step (7). Using the V_o/L_o ratio decided upon and assuming the total amount stripped, compute $\frac{KV_o(1+\Sigma Y)}{L_o(1+\Sigma X)}$ for each component and get amounts absorbed by means of Fig. 28. Computed amount stripped should check assumed, if not, repeat Step (7).

Step (8). Stripping of key component by Step (7) should check desired stripping. If not, repeat Steps 4, 5, 6, and 7 with adjusted total recovery.

The above Type III procedure is illustrated by the following example:

Example 17. Design a stripper (find number of theoretical plates and quantity of steam) to strip 95 per cent of the n-pentane from the rich oil in Example 15.

Step 1. With 60 F cooling water enough of the stripped hydrocarbons will be condensed at 150 psia to make this a satisfactory operating pressure, particularly when 150-lb stream is more readily available than higher pressure steam.

Step 2. Estimate stripping of other components (by equation (73)) relative to stripping of n-C_5.

See Table 22 for these calculations.

Step 3. Find minimum steam-lean oil ratio by trial by applying equation (79) to n-pentane.

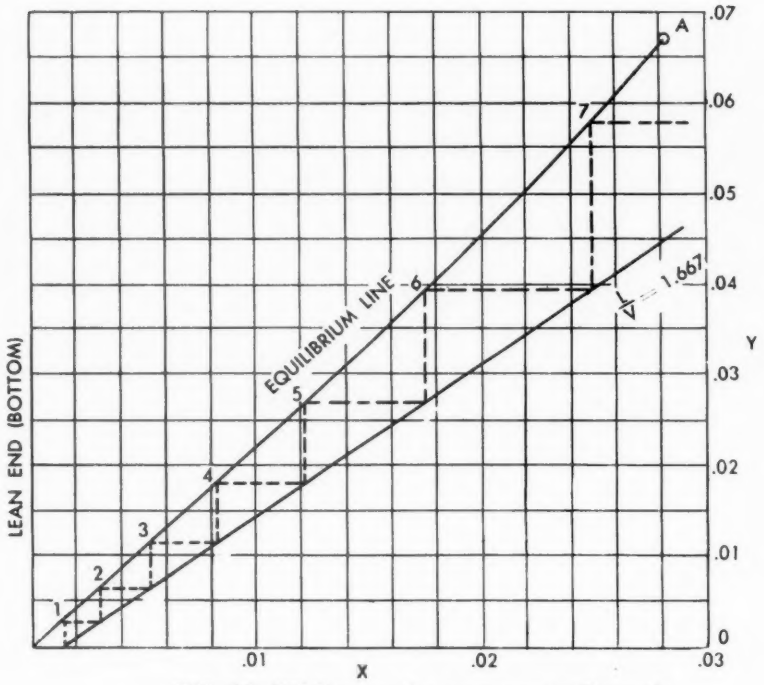

FIG. 36. XY diagram for n-pentane in Example 17 illustrating Type III stripper calculations.

Assumed Vo	V_o/L_o	$\frac{Es(1+\Sigma X)}{K(1+\Sigma Y)}$
200	0.374	0.359
150	0.281	0.330

By interpolation V_o/L_o (min) is found to be 0.352.

For this minimum ratio an infinite number of theoretical plates will be required. Assume a higher ratio and find the number of theoretical plates. Several ratios just above the minimum ratio were tried and rejected because they resulted in too many plates.

Assume V_o/L_o=0.60, V_o=534×0.60 =320 mols/hr.

Step 4. Plot equilibrium line for n-C_5 and find number of theoretical plates.

Slope of equilibrium line at origin, K = 2.2.

At top of column X = 15.01/534 = 0.0282, and

Y (by equation (69)) = $2.2 \times 0.2282 \frac{(1+74.86/320)}{(1+75.59/534)} = 0.067$

Steps 5 and 6. Slope of operating line = 1/0.6 = 1.667.

$X_L = \frac{15.01 - 14.28}{534} = 0.001368$

= intersection on Y = 0 axis.

The operating and equilibrium lines are drawn on Fig. 36 and approximately 7.5 theoretical plates are required at 25 per cent plate efficiency. This is equivalent to 30 actual plates. The optimum choice of column size and steam rate will depend on column cost and steam cost.

Step 7. Compute stripping of all constituents for 7.5 theoretical plates and V_o/L_o = 0.6. Assume total mols absorbed = 74.8 mols/hr.

$$\frac{V_o(1+\Sigma X)}{L_o(1+\Sigma Y)} = \frac{(1+74.8/320)}{(1+75.59/534)} = 0.648$$

See Table 23 for this step.

Step 8. Step 7 shows 97 per cent of n-pentane stripped as against 95 per cent desired. Repeat Steps 4, 5 and 6 using an adjusted steam rate and an adjusted total stripped quantity. Then repeat Step 7 to get total quantity stripped.

TABLE 22. Calculations for Step 2 of Example 17.

Component	Mols/hr in, rich oil	$K^{358°}_{150\text{-lb.}}$	E_s	Mols/hr stripped
Methane	11.76	59	1.00	11.76
Ethane	6.93	19	1.00	6.93
Propane	12.88	9	1.00	12.88
i-Butane	6.18	5	1.00	6.18
n-Butane	15.80	4	1.00	15.80
i-Pentane	7.03	2.5	1.00	7.03
n-Pentane	15.01	2.2	0.95	14.28
	75.59			74.86

TABLE 23. Calculations for Step 7 of Example 17.

Component	Mols/hr in, rich oil	$\frac{KVo(1+\Sigma Y)}{Lo(1+\Sigma X)}$	E_s	Mols/hr stripped
Methane	11.76	38.2	1.0	11.76
Ethane	6.93	12.3	1.0	6.93
Propane	12.88	5.84	1.0	12.83
i-Butane	6.18	3.24	1.0	6.18
n-Butane	15.70	2.59	1.0	15.80
i-Pentane	7.03	1.62	0.986	6.92
n-Pentane	15.01	1.43	0.97	14.58
Total	75.59			75.05

CONCLUSIONS

The above procedure and examples illustrate the Sherwood method of making absorption and stripping calculations. In the next installment comparisons between this method and others will be presented. ★ ★ ★

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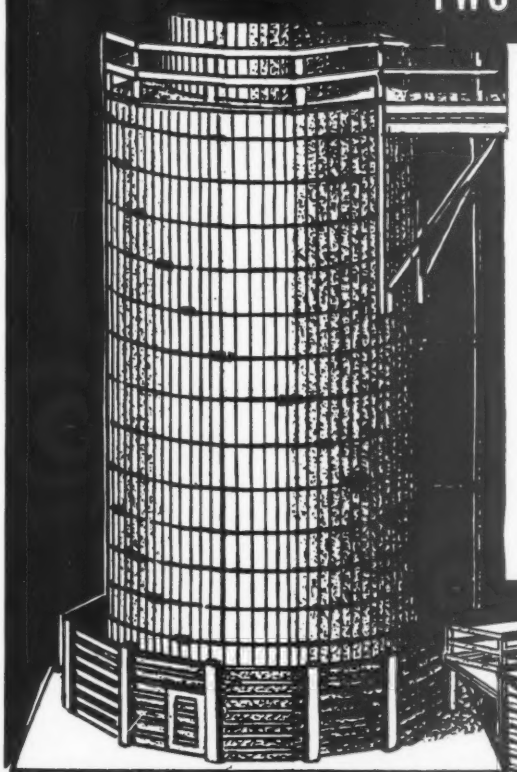

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Progress report on drill string research-non-destructive testing of drill pipe*

By ROBERT C. McMASTER and H. MAURICE BANTA, Battelle Memorial Institute

THIS report presents the results of a preliminary survey of possible methods for the nondestructive inspection of drill pipe. With the exception of the methods now in use, these test methods have not as yet been developed for practical application to drill pipe inspection. Since the original publication of this report, the American Association of Oilwell Drilling Contractors has retained Battelle Memorial Institute to conduct a year's research on methods for the nondestructive testing of drill pipe.

● **Summary.** This report is written so that specific information can be located from the index or section headings. Each topic is discussed rather completely under its heading, so that it can be understood without necessarily reading the remainder of the report.

The report presents a survey of methods and a discussion of problems involved in the nondestructive testing of drill pipe. The nature of drill-pipe failures and their relation to drill-pipe defects are discussed. The causes and effects of laps, seams, plug cuts, and other mill defects in new drill pipe are listed. Defects in used drill pipe resulting from corrosion and from fatigue (which cause washouts and twist-offs in the hole) are found to be essentially different from the mill defects. Seven possible methods of testing new drill pipe in the mill are outlined, while ten other methods are suggested for testing used drill pipe in the field.

It is pointed out that to date there have been no adequate tests of the effects of drill pipe defects upon the time and frequency of occurrence of drill-pipe failures. Without such data, the interpretation of the results of mill and long-term field inspection of drill pipe will of necessity involve personal judgments based on experience and analysis. This would require skilled inspectors and allows the possibility of more than one interpretation of the significance of defects revealed during inspection.

Recommended procedures are suggested for improving the quality of mill and of field inspection of drill pipe. It is concluded that the most promising mill inspection methods appear to be those in which the drill pipe is scanned automatically and all significant defects located and marked so as to bring them to the inspectors' attention. The final acceptance or rejection would be based on the decision of skilled inspectors, using sensitive inspection devices to supplement visual inspection. The most promising field inspection methods appear to be those in which the drill string is inspected automatically, during each trip out of the hole, for incipient washouts and fatigue cracks likely to cause failure in the hole prior to the next trip. Dangerous defects could be marked prominently on the pipe, and an alarm would notify the crew of the drilling rig that the joint should be removed from the drill string. The most useful improvement in long-range field inspection, in which drill pipe is laid down on a rack and inspected carefully, appears to be the development of automatic scanning devices that would locate and mark each defect for the inspectors' attention, and devices that would indicate the depth of defects. The latter developments would probably be expensive and require pipe-handling machines.

*Report first published in *The Drilling Contractor* August 15, 1946, under first line of this title. Revised for *The Petroleum Engineer* by Robert C. McMasters, Assistant Research Supervisor.

● **Introduction.** It has been observed that, in the operation of some new strings of drill pipe, a few failures may occur very shortly after the pipe is placed in service. Following these few premature failures, the remainder of the string may give excellent service over a long period of time until wear, fatigue, or corrosion, or a combination of these factors, together with operating conditions, finally causes frequent failures. When the frequency of the failures, or the possible cost of failures, makes it uneconomical to continue the operation of an old string, the pipe is then taken out of service.

Although more is being demanded of drill pipe as a result of the steady increase in the drilling depths, there has been no significant improvement in the inspection procedures used by the pipe manufacturers for determining the surface quality, both the outside and the inside surfaces being inspected visually by the unaided eye. Although the drilling performance indicates that this inspection procedure is adequate in most cases, the occurrence of some early failures in occasional new strings indicates that some joints of pipe are getting into the field that should have been rejected at the mill.

During recent years, considerable progress has been made in methods and the equipment used for nondestructive testing. It is recognized, however, that the inspection of drill pipe presents numerous difficult problems. In addition to the technical problem accompanying the development of satisfactory equipment suitable for the inspection of drill pipe, few, if any, actual data are available concerning the effects of the various types of defects upon the service life of the drill pipe. While some failures may be associated with seams, laps, plug cuts, and rolled-in scale, the number appears to be relatively small, although all hot-rolled seamless pipe have these defects in various degrees of severity. The question of how extensive a seam, lap, or any other type of defect must be in order to influence the operating life of drill pipe is a vitally important problem, and one for which no good answer is available at the present time.

Although an improved method of inspection at the pipe mills would be advantageous, the use of a nondestructive method of inspecting the drill pipe at regular intervals while it is in service appears to offer the most attractive possibilities from an economic standpoint. If means could be provided for inspecting the pipe while making a trip out of the hole without interfering with the operation, a large percentage of the failures could be detected while still in an early stage of development and those joints removed from the string before a twist-off occurred.

It is the purpose of this report to discuss the various methods of nondestructive testing that might be used to advantage for the inspection of drill pipe at the mill and in the field. The provision of a reliable inspection tool that reveals the presence and extent of each pit and crack will not solve the drill pipe field inspection problem by itself. An intelligent inspector will be required to make personal judgments on the basis of his experience and analysis, in order to predict drill pipe performance for more than a very short period in advance. The larger cracks and the incipient washouts are another matter, however, since failure of the drill string usually develops rapidly from these defects. Such large defects and cracks might be reliably detected by testing devices that operate and discriminate solely on the size or extent of the defect. Such a tester would probably have to be a field device not necessarily requiring a skilled operator and could be used on each string frequently enough to detect incipient failures before they have a chance to occur in the hole.

● **Drill pipe defects. New drill pipe.** Defects in new drill pipe, other than possible failure to meet the physical and dimensional specifications, generally

seem to be limited to laps, seams, plug cuts, inclusions and (rarely) porosity or blow-holes. Each of these are local conditions of random occurrence and position, resulting from the effects of inclusions or blowholes in the ingot from which the pipe was made and from the conditions of piercing and rolling. Ingot inclusions are particles of impurities, usually oxides, sulphides, silicates, and such, which are mechanically held during solidification or which are formed by subsequent reaction of the solid metal. Blowholes are holes produced during the solidification of metal by evolved gas that, in failing to escape, is held in pockets. The number and location of such ingot defects are subject to random variations, but steel manufacturers have gone to a great amount of study and effort to produce cleaner steels, which has resulted in a lower average inclusion content for the high-grade steels. Ingots are cropped (i.e., the ends of the ingot containing pipe or other defects are cut off and discarded), and it is common practice before piercing to peel rounds, in addition to treating them by conventional chipping methods. There is some indication that the center and bottom portions of the ingot often contain more defects than other regions, and that the number of defects per ingot may be a function of tapping and pouring temperatures, pouring times, and other production variables. However, despite precautions, all steels contain inclusions. As an absolutely clean steel is unobtainable, it is necessary to use steels with some inclusion content.

In drill-pipe production, the ingots are rolled from blooms into rounds. Drill pipe is produced from the rounds by rotary piercing. Two steel rolls are placed side by side and have their axes inclined at opposite angles (6-12 ft) with the horizontal centerline of the mill. They bring into play forces used to produce the cavity in the work piece. Owing to the obliquity of the roll axes, the motion imparted to the round by the rolls is one of rotation and axial advance. The elevation of the centerline of the pass is determined by two guides, one of which is mounted above, and the other, below the center of the mill. Between these guides in the pass outlet a tapered piercing mandrel is held in position on the end of a water-cooled mandrel support bar located on the declivery side of the mill. The opposite end of this support bar is mounted in a thrust bearing. When the leading end of the round has advanced to the gorge, it encounters the nose of the piercing mandrel. Once the end of the piercing mandrel has penetrated the axial center of the round, the mandrel serves as a third roll so that, with a properly designed pass, the metal of the work piece is helically rolled over the piercing mandrel (rather than extruded) to produce the hollow drill pipe. With large tubes, further reduction in the thickness of the hollow pipe is obtained through additional rolling in a second piercing mill. In this mill, the piercing mandrel is replaced by a "plug," which has little taper.

Piercing introduces seams and laps at both the inner and outer surfaces of the drill pipe. Seams are cracks on the surface of the metal which have been closed but not welded. They are usually produced by blowholes that have become oxidized. Laps are surface defects appearing as a seam caused from folding over hot metal, fins, or sharp corners and then rolling or forging, but not welding, them into the surface. As a result of the piercing process, these defects usually progress helically along the surfaces of the drill pipe. It has been found through experience that the piercing mandrel must be covered with oxide (which serves as a lubricant) in order to pierce rounds successfully. Thus, piercing and rolling introduce the possibility of rolling mill scale into both the inner and outer tube surfaces. (In the second piercing, spalling and hard particles caught on the plug may produce the type of defects known as plug cuts.) Seams, laps, plug cuts, and included mill scale are ordinarily present in all drill pipe as a natural consequence of the method of fabrication.

Much rarer in occurrence in new drill pipe are defects such as porosity or blowholes (as rolling and piercing tend to convert these defects into seams and laps), cracks (due to heat treating), and flakes (internal fissures in large steel forgings or massive rolled shapes).

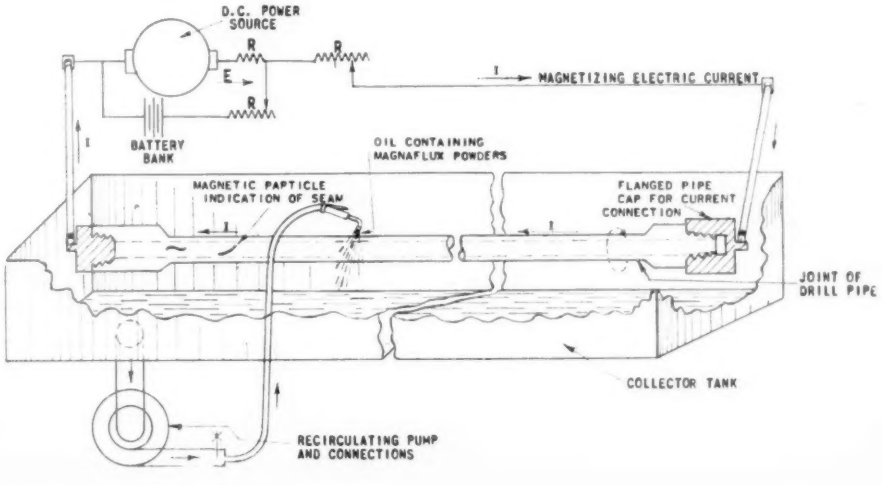
The common defects in new drill pipe are, by their nature, not adapted to economical or automatic inspection procedures. Laps and seams are exceedingly thin, irregular surfaces with no appreciable voids and only a thin, broken film of oxide or inclusion (perhaps only a few molecules thick) with properties different from those of the steel itself. Such films are seldom continuous, so that the steel makes intimate contact at many points across the defect. They are not easily detected by X-rays or gamma rays, by the flow of heat or electricity, or by any type of measurement involving a large volume of metal in its indication.

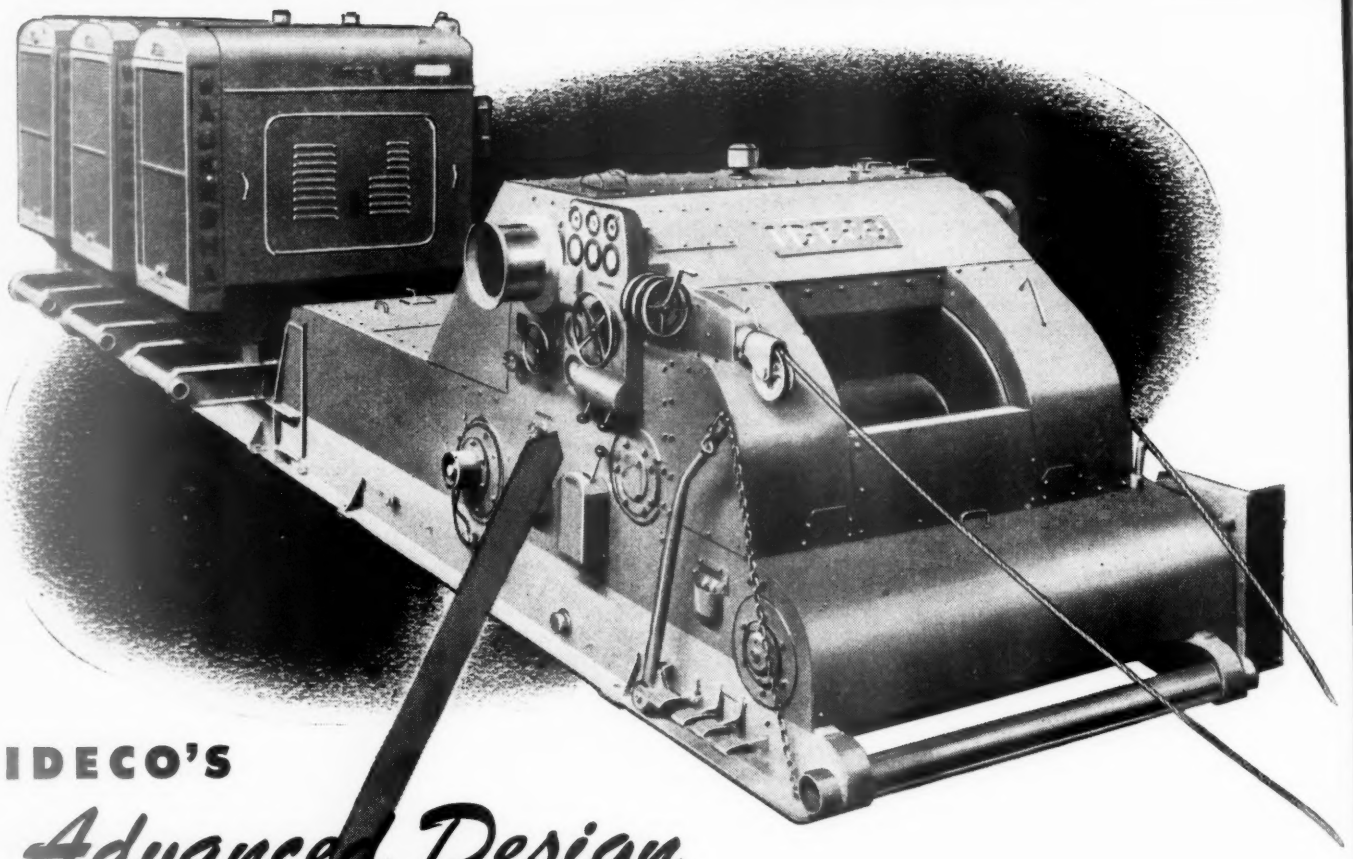
The real significance of seams and laps has not been fully determined in connection with drill-pipe operation. It appears to be a generally accepted conclusion that small surface laps and seams have no significant effect. In some cases, seams and laps that extend deeper than 12½ per cent of the tube wall thickness are considered rejectable, simply because that depth corresponds to the lower tolerance limit on wall thickness. Many drill strings giving excellent performance contain thousands of laps and seams. Obviously, it is not feasible to use an inspection method that detects and rejects all laps and seams. Extensive field observations or physical tests would be required to establish even tentative standards for the acceptance of drill pipe on the basis of mill defects. Probably, skilled observers or inspectors would be needed to interpret indications of mill defects in terms of drill pipe serviceability.

● **Used drill pipe.** Defects that produce failures in drill pipe after long periods of drilling service bear, for the most part, little or no apparent relation to the initial defects in the pipe when it was new. The washouts and twist-offs appear to be caused most frequently by the development of a fatigue crack from a pit produced by corrosion or, in some cases, from surface nicks and stress concentrations due to handling and use of the drill pipe in the field. Drill pipe used in the Permian Basin region of West Texas usually develops thousands of corrosion pits per joint, and fine cracks develop from many of these pits. The danger point in crack development, at which the wall is penetrated and a washout begins, is the critical stage that should be anticipated by a field test. Extensive observations would be desirable in order that this limiting condition be defined adequately to serve as a standard for inspection.

Two types of field test deserve consideration. The first type is the sensitive

FIG. 1. Magnaflux equipment for mill inspection of new drill pipe. Magnetizing current passing longitudinally along joint of drill pipe produces a circumferential magnetic field. This field has a component normal to spiral seams and laps, and to longitudinal plug cuts, so that particles of magnaflux powder are attached to these discontinuities where they reach the pipe surface.





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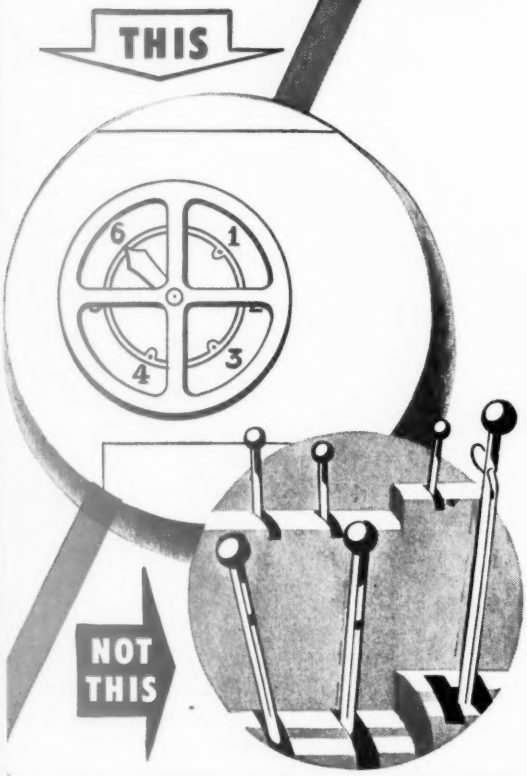

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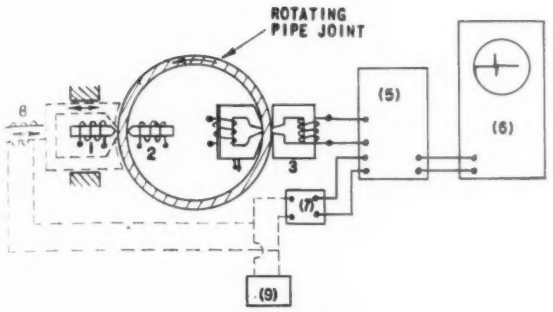
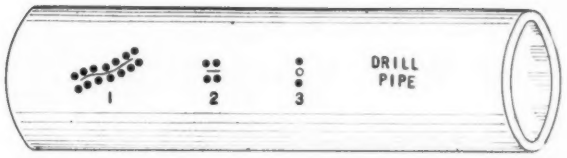


(a) Schematic arrangement of sensitive magnetic pick-ups and auxiliary equipment. Only one type of pick-up would be used. An inside pick-up could be used where feasible. Pipe is rotated and advanced past pick-ups.
1, 2. Open magnetic circuit-type sensitive pick-up units.
3, 4. Closed magnetic circuit type sensitive pick-up units.
5. Amplifier.
6. Cathode ray oscilloscope or recording meter (not essential in production models).
7. Relay adjusted to operate only on rejectable defects.
8. Solenoid-actuated marking device (brackets defects with visible rows of dots).
9. Visual or auditory alarm to warn inspector that defect has been registered.



(b) Typical markings indicating that defects have been registered. Prominent light paint dots would outline defects.
1. Seam or lap outlined by dots.
2. Short plug cut outlined by dots.
3. Hole or pit outlined by dots.

FIG. 2. Schematic arrangement of equipment for locating defects in new drill pipe by sensitive magnetic measurement. Pipe is moved so as to be scanned along a spiral path, so entire surface is inspected.

complete test made at intervals of the order of several months, in which an entire string is pulled slowly or even laid down and examined throughout. Such a test should discriminate all joints liable to fail during the period preceding the next inspection. This inspection requires high sensitivity and a skilled inspector whose judgment would be a significant factor determining the reliability of the inspection. The second type of field test would be an automatic self-indicating "go or no-go" type of test, performed rapidly and automatically as the drill string was raised from or lowered into the hole. This test would be expected to indicate incipient washouts —defects that have already grown sufficiently so that washouts might possibly occur during the next 24 hrs of drilling. This would be a faster, but much less sensitive type of inspection than the former.

● **Mill inspection. Present inspection methods.** At present, drill pipe quality is controlled in the steel mill by careful process control during fabrication, and visual inspection of the finished product. Such visual inspection includes an examination of both inside and outside surfaces of the drill pipe for laps that have opened up, dimensional tolerances, concentricity, thread accuracy, and similar properties. In general, seams and laps are carefully inspected, but no ready means of nondestructively determining their depth is available. Where it is suspected that a seam or lap may exceed the 12½ per cent of wall thickness acceptance limit, this condition may be checked by filing or grinding to the bottom of the defect. Inspection of the interior surface of the drill pipe consists of looking through the drill pipe while a light source is held at the other end of the pipe, and observing any irregularities or projections from the inner surface of the pipe. The lack of proved correlation between the presence of minor mill defects and drill-pipe failures; and the relatively good performance of new drill pipe, have not, to date, led pipe manufacturers to use any more extensive inspection of drill pipe in the mill.

● **Possible additional mill inspection methods.** Several additional methods might be developed for mill inspection of drill pipe. The value of elaborate or costly mill tests is questionable, in the absence of reliable data on what constitutes a rejectable defect liable to cause drill pipe failure; however, those tests that locate possible defects and bring them to the attention of the inspector may have significant value, since these would greatly increase the detail and quality of visual inspection and would permit the inspector to focus his attention upon the significant defects without greatly increasing the time required for inspection.

● **Magnaflux inspection.** Magnetic particle inspection ("Magnaflux") and the related methods, such all the fluorescent penetrant method ("Zyglo"), reveal surface seams and laps, as well as other surface defects. The methods are highly sensitive to defects that come to the surface of the pipe, but it is very difficult, or perhaps impossible, to use them to discriminate the depth of a seam or lap. It would be possible to inspect not only the outer, but also the inner tube surfaces by these methods, if interior inspection were carried out with the aid of a suitably illuminated magnifying borescope; however, the time and cost of such inspection would be completely out of line with the proved merits of the method or the possible improvements in drill-pipe performance that could be obtained as a result of such inspection. To obtain reliable information on the depth of seams or laps, they would have to be ground down. If all joints of drill pipe that showed extensive indications by these test methods were rejected arbitrarily, the rejection rate would be so high that the final cost of drill pipe would have to be greatly increased. This could be justified only after extensive physical tests had proved that the inspection method was detecting those defects liable to cause premature drill-pipe failures. However, the Magnaflux method has the advantage of being fully developed and commercially available, so that if it were found useful, it could be applied in production almost immediately and with no initial development cost. A typical layout is sketched in Fig. 1.

● **Sensitive surface magnetic field measurement.** A sensitive method of measuring local discontinuities and variations in the magnetic field strength at the surface of ferrous material, using principles applied in magnetic wire recording, has been developed during the war period in connection with the nondestructive testing of flash welds. In this test, the surface being inspected is scanned by a pickup unit similar to those used to pick up minute variations in the magnetic field strength of the signal on the wire of a wire recorder. The unit responds to exactly the same conditions as do the iron particles in magnetic particle inspection, giving an electrical signal in response to laps, seams, and surface discontinuities that affect the surface magnetic field strength. Its sensitivity is readily adjustable and can be made at least as great as the optimum magnetic particle sensitivity. The electrical signal may be amplified and applied to the screen of a cathode ray oscilloscope, to a recording meter, or other indicators. If desired, the electrical signal could be caused to actuate a mechanism that would bracket the defect region with parallel lines of dots of a distinctive paint, as well as actuate a suitable alarm or indicator to warn the inspector of the existence of a defect. For drill-pipe inspection, pickups might be placed in contact with both the inner and outer tube surfaces and the tube rotated while the pickups are

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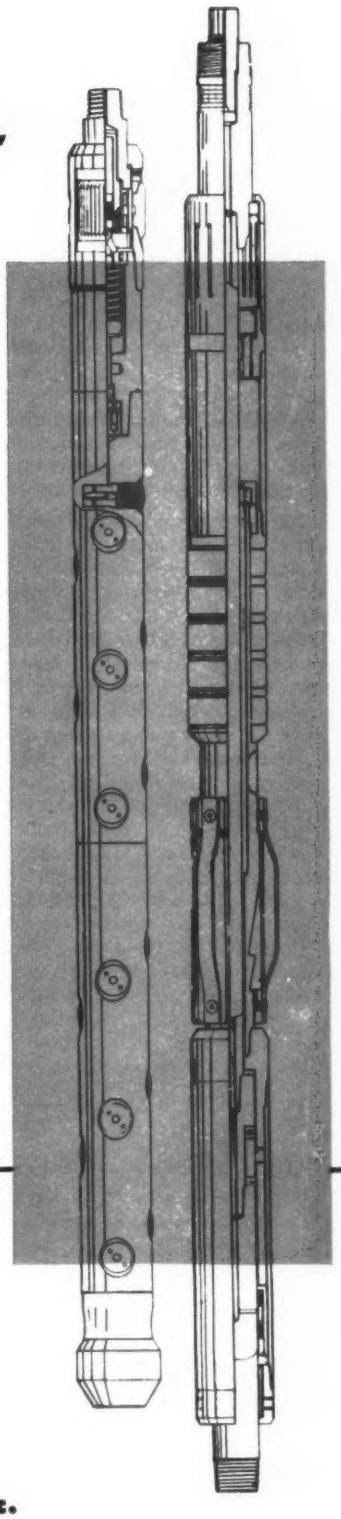

A combination Gun-Perforator and Formation Tester, which has been developed, perfected and field-tested for over two years by the Perfo-Test Company and Hunt-Clark Company, Spartan subsidiaries, under the management of H. F. Clark. With this device, casing is perforated at the desired level and a test is immediately made of the productivity of the formation. In cases where a previous set of perforations has been squeezed and before another set is shot, the Perfo-Tester can make a dry test on the result of the previous squeeze job. The Perfo-Tester is then immediately ready to again perforate the casing and to make a productivity test of the formation. Perfo-Tester crews have already been trained, and are ready to operate for Spartan. In addition, fifty modern cementing units and thirty-seven bulk-cement units are scheduled for delivery within six months. The first of these is ready to serve you now.

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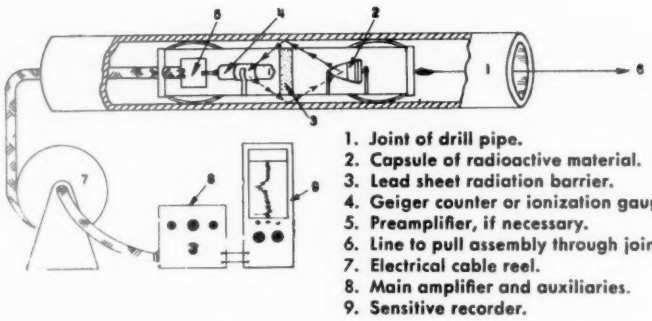
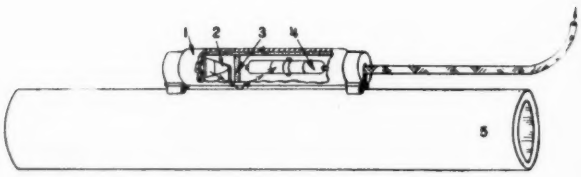


1. Joint of drill pipe.
2. Capsule of radioactive material.
3. Lead sheet radiation barrier.
4. Geiger counter or ionization gauge.
5. Preamplifier, if necessary.
6. Line to pull assembly through joint.
7. Electrical cable reel.
8. Main amplifier and auxiliaries.
9. Sensitive recorder.

(a) Schematic arrangement of components used for back reflection of gamma ray for inside of drill pipe.



(b) Schematic arrangement of components used for back reflection of gamma-ray tests from outside surface of drill pipe. Pipe must be rotated under detector to scan all surface.
1. Lead shielded housing to protect personnel from radiation.
2. Capsule of radioactive material.
3. Lead barrier to protect radiation detector from a direct beam of radiation from source.
4. Radiation detector.
5. Joint of drill pipe.

FIG. 3. Typical arrangements of components used in back reflection of gamma ray for inside of drill pipe.

passed along its length, or the same relative spiral motion obtained in other ways. (See Figs. 2 and 16.) This would provide a rapid, low-cost, automatic method of obtaining the information provided by magnetic particle inspection with much more prominent indication of the existence and location of defects.

Such a method as this would require appreciable development before its application in production. Means would have to be found for maintaining the pickups at nearly constant distances from the surfaces of the pipe. It would be necessary to develop means of preventing excessive response to large area surface irregularities caused by the piercing and rolling operations. Mechanisms for handling and rotating the pipe would be required. Suitable recorders or markers to indicate defects would have to be developed. The end result would be a rapid and efficient means of obtaining information similar to that revealed by Magnaflux, but, like Magnaflux, the method would fail to indicate the depth of the defects. Each defect would have to be checked by the inspector, and rejections would be made on the basis of his personal judgment and experience. The method would be a low-cost, rapid substitute for Magnaflux serving, like Magnaflux, only to locate but not to evaluate defects.

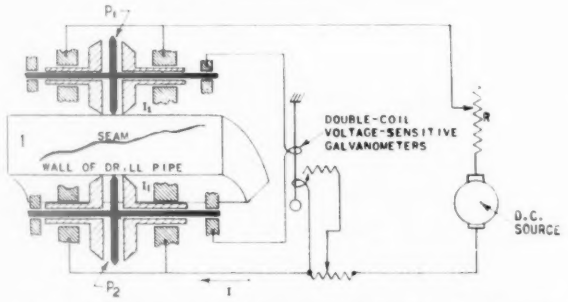
● **Methods involving local stress measurement.** Several test methods have been developed that detect, it is claimed, the state of stress within local regions of the material. Such tests would be applicable to the mill inspection of drill pipe if the mill defects such as laps, seams, and plug cuts do produce significant local stress concentrations when the pipe is stressed by external load. The possibility of significant stress concentration effects increases with the depth of the defect, so that stress detection tests offer some hope of being sensitive to the depth of defect. It remains to be proved that external loads can be applied in such magnitude and in such a manner as to cause detectable stress concentrations at defects, without exceeding the yield strength or otherwise damaging the drill pipe.

One method of indicating the state of internal stress in metallic materials is by use of diffraction or back reflection of X-rays or gamma rays. Changes in the crystal lattice spacing resulting from a state of stress cause corresponding changes in the pattern of the diffracted radiation. The method has been developed during the war period for the examination of aircraft engine castings, for nondestructive inspection of boiler tubes and refinery tubes, for measuring the thickness of metallic materials and of coatings, and has even been applied to the examination of drill pipe in the field[1]. It has been extensively investigated during the last ten years as a possible method of indicating or predicting fatigue damage, but has not been generally accepted as a practical or reliable indicator in this case.

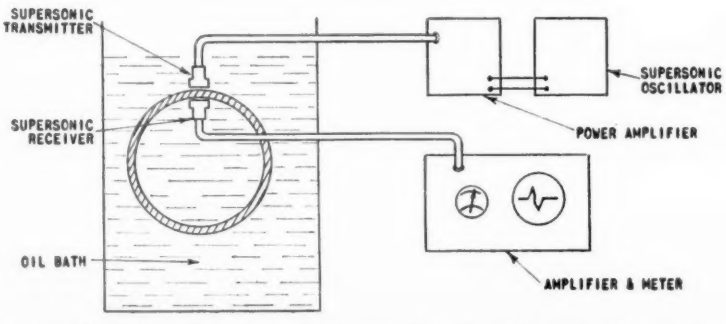
The radiation may be produced by a suitable X-ray tube (with auxiliary power supply and control equipment) or by a capsule of radioactive material. The X-ray tube can be arranged to provide a copious supply of low-voltage radiation, but the auxiliary equipment is extensive and bulky, and most X-ray tube housings are too large to permit the X-ray tube to be inserted within drill pipe. The capsules of radioactive material are small and can be readily placed inside, as well as outside, the pipe; however, they produce very penetrating radiations that, in any reasonable amount, are dangerous to personnel and difficult to confine behind barriers. If very small amounts of radio-active ma-

[1]Electrograph Company, 1750 N.E. 10th Street, Oklahoma City 4, Oklahoma.

FIG. 4. Arrangements for electric current and supersonic conduction through discontinuities as possible nondestructive tests. These tests would not be sensitive to seams and laps where the metal has broken through the oxide films to produce conducting paths across the discontinuities.



(a) Possible arrangement (shown schematically) of components of two-side electric current conduction test. Such a test as this would be feasible only if it can be demonstrated that seams and laps which influence drill pipe failures do contain insulating films of oxides or other materials, which are not broken through as a result of piercing and rolling.



(b) Possible arrangement of components of two-side supersonic conduction test. Drill pipe and supersonic transmitter and receiver are immersed in oil.

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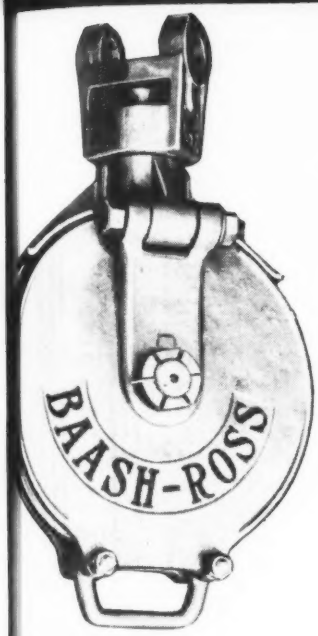

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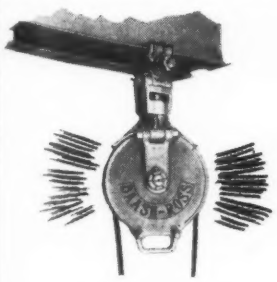
1. **Bending lines around corners, such as in snatch-block applications.**
2. **Supporting lines in the rig for lifting tools and equipment.**
3. **Small traveling block applications for reducing line loads during hoisting operations.**

And the Baash-Ross Universal Utility Block is unique in that, simply by changing inexpensive accessory units, this *one* block will handle any of these *three* types of jobs. What's more, its capacity is 39 tons with 2 to 1 safety factor!

For example ...

FLOOR BLOCK: Simply attach a base plate and you have a Floor Block that can be used with portable pulling outfits in well servicing work. Positive stops allow the Block to tilt 45° in any direction and a roller bearing swivel allows it to follow the line freely as it spools on and off the drum. To save time, in moving the Block from rig to rig, you can anchor an inexpensive base plate on each rig floor and quickly mount the Utility Block by inserting just one anchor bolt between plate and Block.



CORING BLOCK: When you need a small block in the crown for handling bailing and coring lines, simply attach a beam hanger unit to the Utility Block, fasten the beam hanger to a crown beam and you're ready to roll.

The hanger can be placed at any convenient point on the crown beam and when tightened, will not slip. The full-swiveling and tilting features permit the Utility Block to follow the line freely, minimizing wear on both line and sheave.

TUBING BLOCK: Fasten a tubing block clevis and your Utility Block is ready to serve as a Tubing Block in a wide range of well servicing applications. The clevis is free to swing from side to side and is also free to rotate ... or can be locked against rotation by means of a built-in pin. The heavy-duty tapered roller bearing on the sheave gives the unit a high working capacity.

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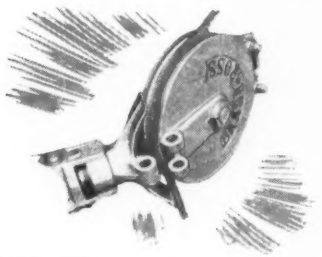
Three-way adaptability is only part of the story on the Utility Block. Look at these top quality construction features ...



- Side opening feature (by simply removing one bolt) saves time in placing lines around the sheave.
- Capacity 78,000 lbs.—with 2 to 1 safety factor.
- Sheave is alloy steel, 18" dia.—with flame-hardened groove 14½" dia.
- Bearings in both sheave and swivel are heavy-duty tapered roller type.
- Full 360° swiveling in all applications—or swivel may be locked by built-in pin.
- High pressure grease ducts direct to sheave and swivel bearings.
- Rope cannot jump sheave—guarded by side plates.

The Baash-Ross Universal Utility Block makes important savings on small-block inventories and it is available grooved for any line from ⅜" through 1".

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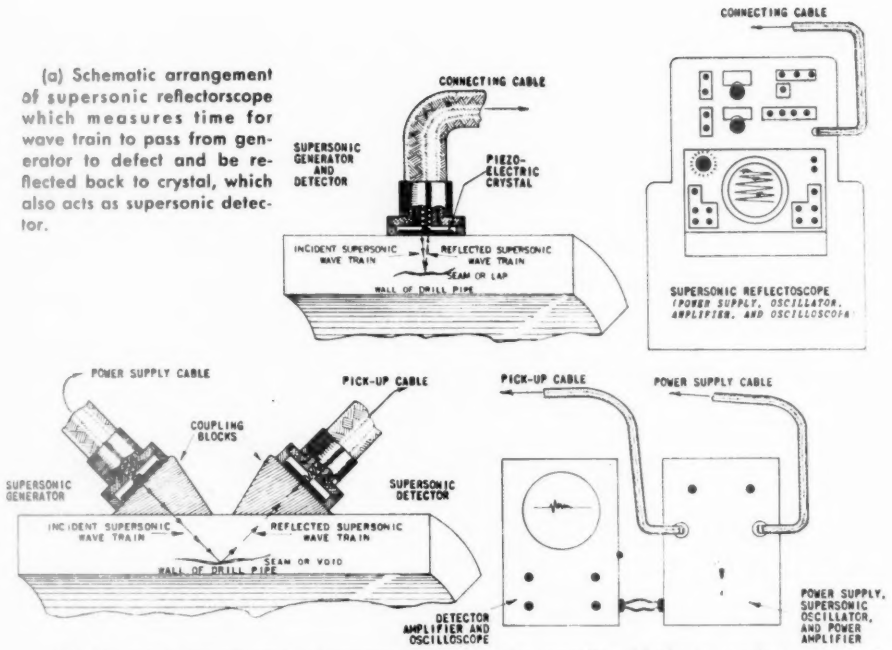

(a) Schematic arrangement of supersonic reflectorscope which measures time for wave train to pass from generator to defect and be reflected back to crystal, which also acts as supersonic detector.
CONNECTING CABLE
SUPERSONIC GENERATOR AND DETECTOR
PIEZO-ELECTRIC CRYSTAL
INCIDENT SUPERSONIC WAVE TRAIN
REFLECTED SUPERSONIC WAVE TRAIN
SEAM OR LAP
WALL OF DRILL PIPE
SUPERSONIC REFLECTOSCOPE (POWER SUPPLY, OSCILLATOR, AMPLIFIER, AND OSCILLOSCOPE)
POWER SUPPLY CABLE
PICK-UP CABLE
COUPLING BLOCKS
SUPERSONIC GENERATOR
SUPERSONIC DETECTOR
INCIDENT SUPERSONIC WAVE TRAIN
REFLECTED SUPERSONIC WAVE TRAIN
SEAM OR VOID
WALL OF DRILL PIPE
DETECTOR AMPLIFIER AND OSCILLOSCOPE
POWER SUPPLY, SUPERSONIC OSCILLATOR, AND POWER AMPLIFIER
(b) Schematic arrangement of supersonic tester using coupling blocks to conduct supersonic signals into wall of pipe. Separate crystals are used for generator and detector. The spacing between source and detector is adjustable for fault location.

FIG. 5. Supersonic reflection tests for voids in drill pipe. This test would be useful only on seams or laps which presented a true discontinuity in supersonic conduction, and would not be reliable where no true void or insulating film existed. The thin walls of drill pipe require higher supersonic frequencies than are used for thick billets.

terial are used, relatively long periods of time are required to obtain an indication from a single small area, so that scanning an entire joint of drill pipe would be a lengthy and expensive operation. However, both types of radiation source might be developed, if desired for practical use in mill inspection of drill pipe.

In laboratory developments, the diffracted radiation patterns are recorded on X-ray film, which is then developed and inspected for small shifts or changes in the characteristic spot or line pattern. This procedure is obviously impractical for drill-pipe inspection. Alternative methods, more rapid but less sensitive, involve the detection and measurement of the scattered or diffraction radiation by means of Geiger counters or by sensitive ionization gages. The latter instruments integrate the total reflected radiation without distinguishing detailed line or spot patterns. The relations between their indications and the actual stress patterns are usually rather complex and require extensive experience for reliable interpretation.

The diffraction patterns might be obtained for drill pipe with any of several possible combinations of locations for radiation source and detector. In order that the detector be sensitive to minor changes in diffracted radiation, it is desirable to screen it as well as possible from intensive direct irradiation by the source. This is often done with lead sheets or baffles of thickness sufficient to reduce the indication of radiation direct from the source to a reasonably small amount in comparison with the magnitude of the reflected radiation. If high response sensitivity is to be obtained for stress concentrations in local regions of the drill pipe, it is desirable to concentrate the radiation beam onto the region of interest and to shield adjacent regions from exposure. Typical arrangements of components are sketched in Fig. 20. Those arrangements in which a small local area is irradiated tend to be more sensitive to defects than arrangements that irradiate large areas or large circumferential rings. They also require more sensitive detectors and more detailed scanning of the surface of the pipe during inspection.

The output electrical signal from the detectors may be amplified (although the amplification of nearly constant direct current signals introduces difficulties) and recorded on paper or film or other direct indicator. Like the sensitive magnetic instrument previously described, the output signal could be used to mark the drill pipe directly in the region of the defect. A final visual inspection would be necessary, in most cases, to identify the source of the indication of stress and to judge the suitability of the drill pipe for service.

Another method of measuring the state of stress in a ferro-magnetic material involves indications of the hysteresis and eddy current losses that occur when an alternating magnetic field is applied to the material under test. Such devices have been developed commercially under the trade name "Cyclographs."[2] They have been used for sorting of parts and materials, for discrimination of composition, heat treatment, and physical properties of ferrous and nonferrous materials, and for measuring regions of stress concentration in stressed materials. The relation between changes in the hysteresis and eddy current losses and the defects or stress concentrations that produce them is very complex. Extensive tests and development would be required before all variations in stress patterns could be interpreted from test indications. Special coil arrangements would have to be developed to obtain optimum indications of defects in terms of the stress concentrations produced by the defects. Means of applying suitable external load to the pipe during inspection would probably be important. Defects could be signalled or recorded by any of the methods previously mentioned.

It is probable that other physical properties of steels change with the state of stress, but no other methods of detecting the state of internal stress have been developed to a stage of commercial practicability.

● **Methods involving measurements of conduction through discontinuities.** Large voids and significant discontinuities in physical properties may be detected by any of a variety of conduction tests. Such tests involve the conduction or transmission through the material of heat, electric currents, vibrations or supersonic waves, X-rays, and other radiations. Ordinary steady-state conduction tests are suitable for the detection of inclusions, voids, cracks, wall thicknesses, and other properties and defects that influence the volume distribution of material in the specimen being inspected. They are not suitable, in general, for the detection of seams, laps, and similar defects which introduce no measurable volumes of voids or significant insulating discontinuities. When seams and laps occur during piercing and rolling, the two surfaces of material are pressed tightly together, forming thousands of points of relatively good contact and tending to pierce or break up any oxide or inclusion films that happen to be present initially. Heat, electricity, X-ray, and, in some cases, sound waves are conducted across the discontinuities almost without interference. Hence, ordinary conduction tests must be exceedingly sensitive to detect seams and laps, particularly when these lie deep under a volume of sound metal (Fig. 4a).

Conduction tests might be feasible, however, if developed to a state of high sensitivity to the presence of laps and seams without being excessively influenced by other conditions such as surface irregularities. If seams and laps were formed with a reliable layer of insulating material, these might be detected reliably. If, by the application of external loads, it were possible to stress drill pipe so as to open up deep seams and laps without otherwise damaging good drill pipe, conduction tests might

[2]Allen B. Du Mont Laboratories, Inc., Passaic, New Jersey.

become very valuable. In the absence of such fortuitous developments, ordinary conduction tests do not appear to be a promising method of inspecting new drill pipe.

Conduction tests may be made more sensitive if the energy flow can be concentrated into narrow beams. This may be done with supersonic waves, but no means has been found for limiting the flow of heat or electricity to narrow beams in continuous conductors. Commercially available equipment[3] has already been developed for supersonic conduction tests and could probably be modified and further developed for use with drill pipe (Fig. 4b). However, it has not yet been adequately demonstrated that supersonic conduction tests reliably discriminate all significant mill defects in drill pipe.

● **Methods involving measurements of reflections from discontinuities.** Energy beams capable of being *reflected* from defects and discontinuities provide a sensitive means of flaw detection. Supersonic testing equipment of this type has been extensively developed during the war period[4], with operating wave lengths suitable for thicknesses of several inches to several feet of steel (Fig. 5). The wall thickness of drill pipe is at the lower extremity of the operating range, and modifications for higher frequency operation or other changes would probably be required to make the method effective with drill pipe. The method has been applied to locate flaws in billets and rounds and would probably be effective in the case of seams and laps with oxide films or other discontinuities in supersonic conduction properties. However, in the case of seams and laps without films of oxides, in which the material on one side of the lap has been pressed into intimate contact with the material on the other side, as is the usual case in drill pipe, there may be much less discontinuity in the conduction of supersonic waves. Careful tests would be required to determine the reliability of supersonic reflection tests in detecting the location and depth of drill-pipe mill defects. The manufacturers of such equipment have not recommended its use for such inspection.

The X-ray back reflection tests previously discussed do not fall into the category of reflections from discontinuities, for the back reflection in the X-ray test was not from material in the discontinuity, but from the overstressed steel in the surrounding region of stress concentration produced by the flaw. The possibility exists, although remotely, that a radiation sensitive only to the material in the film of the discontinuity might be used as a flaw detector. Neutron beams, for example, are influenced greatly by the presence of hydrogen, yet pass relatively easily through many other materials. Hence, there is a remote possibility that seems and laps filled, for example, with a penetrating oil (which contains hydrogen) could be detected by the back gamma ray reflection produced when the drill pipe is bombarded with a neutron beam. Much of the possibility of development of this type test depends critically upon the feasibility of producing narrow, but intense, neutron beams at low cost, and of introducing sufficient quantities of hydrogen-bearing fluids into the defects.

● **Suggested procedure for improving mill inspection of drill pipe.** A reasonable procedure for investigating and perhaps improving the mill inspection of drill pipe might include the following steps:

1. The research investigators should become thoroughly familiar with drill-pipe manufacture, inspection, and defects, by working in the inspection department of a drill-pipe manufacturer for a reasonable period. During this period, the methods of manufacture and inspection would be observed, the nature and frequency of occurrence of defects noted and analyzed, and the present standards of acceptance and rejection evaluated, if possible.

2. The research investigators should then set up a careful additional low-initial-cost inspection procedure, perhaps Magnaflux and Zygol, and examine thoroughly about one in every hundred joints produced and passed by the regular inspection. In addition, all defects that were cause for rejection of joints in the regular inspection should be carefully examined by Magnaflux and by grinding down or sectioning to determine depth and other characteristics. All significant defects should be photographed, together with their Magnaflux indications, and cataloged for future reference. If possible, a reference chart should be prepared, showing acceptable and rejectable defects and the variations of each, together with the corresponding Magnaflux indications. (If it should be impossible to carry out these tests in the mill, they might be carried out in the field on new strings of drill pipe.) If tests were made under conditions in which field records could be obtained of the performance of the

[3]Brush Development Corporation, Cleveland, Ohio.
[4]"Supersonic Reflectoscope," Sperry Products, Inc., Hoboken, New Jersey.

FIG. 6. Arrangement of equipment for field inspection of used drill pipe by dry magnaflux powder method. Circumferential magnetizing coil produces a longitudinal magnetic field which is normal to circumferential fatigue cracks and incipient washouts common in used drill pipe; inside of pipe may also be magnaflux inspected, by use of an illuminated borescope.

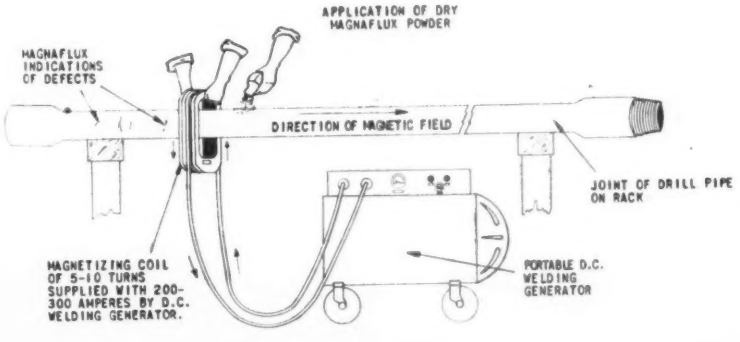
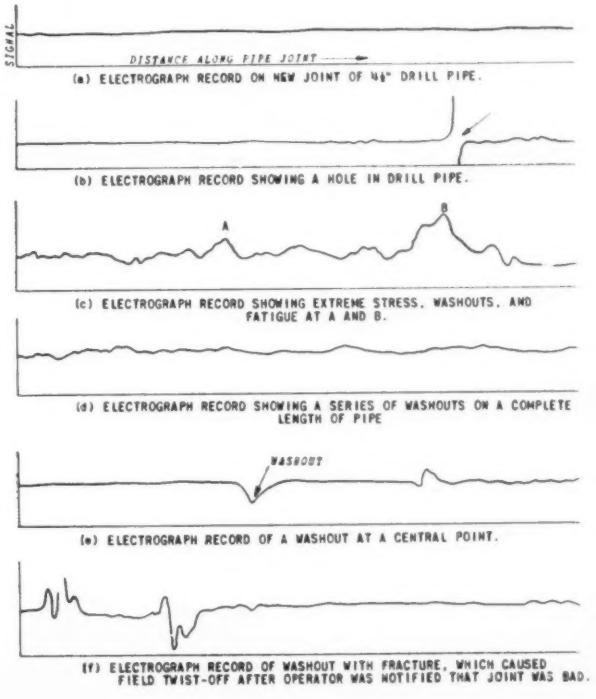
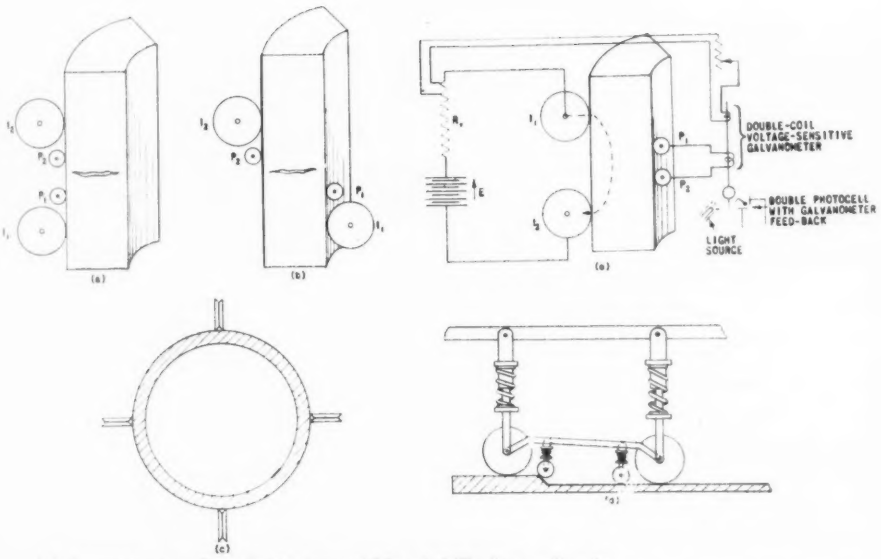

APPLICATION OF DRY MAGNAFLUX POWDER
MAGNAFLUX INDICATIONS OF DEFECTS
DIRECTION OF MAGNETIC FIELD
JOINT OF DRILL PIPE ON RACK
MAGNETIZING COIL OF 5-10 TURNS SUPPLIED WITH 200-300 AMPERES BY D.C. WELDING GENERATOR.
PORTABLE D.C. WELDING GENERATOR

FIG. 7. Illustrative records of drill pipe inspection. (Courtesy of the Electrograph Company.)


SIGNAL
DISTANCE ALONG PIPE JOINT
(a) ELECTROGRAPH RECORD ON NEW JOINT OF 4½" DRILL PIPE.
(b) ELECTROGRAPH RECORD SHOWING A HOLE IN DRILL PIPE.
A
B
(c) ELECTROGRAPH RECORD SHOWING EXTREME STRESS, WASHOUTS, AND FATIGUE AT A AND B.
(d) ELECTROGRAPH RECORD SHOWING A SERIES OF WASHOUTS ON A COMPLETE LENGTH OF PIPE
WASHOUT
(e) ELECTROGRAPH RECORD OF A WASHOUT AT A CENTRAL POINT.
(f) ELECTROGRAPH RECORD OF WASHOUT WITH FRACTURE, WHICH CAUSED FIELD TWIST-OFF AFTER OPERATOR WAS NOTIFIED THAT JOINT WAS BAD.



(a) Arrangement of electrodes on outside of drill pipe wall only.
(b) More sensitive arrangement with one electrode inside drill pipe (has limited application only).
(c) Arrangement of several electrode systems about pipe circumference, to obtain increased local sensitivity.
(d) Arrangements of electrodes to pass tool joints.
(e) Schematic electric circuit of electric current conduction test.

FIG. 8. Electrode arrangements for electric current conduction tests. A large constant current passes through the wall of the drill pipe from electrode I_1 to eectride I_2. The resultant difference of potential is picked up by potential probes P_1 and P_2, and is measured by a sensitive galvanometer equipped with a photocell amplifier to actuate marking and recording mechanisms when defects pass the unit.

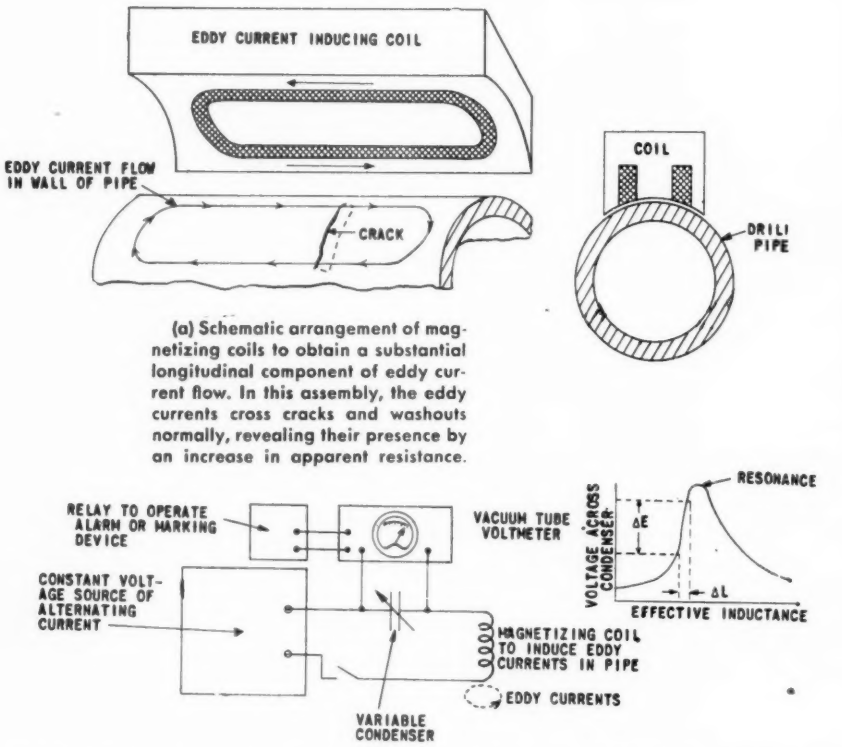
inspected joints, the operating data should be correlated, if possible, with the magnetic particle inspection data.

3. If the preceding preliminary tests indicated that drill pipe performance could be improved by improved mill inspection, proposals would be made for the development and testing of devices previously described that would supplement the visual inspection of drill pipe. Initial effort would be directed toward accessories that would automatically scan all joints and mark the location of all defects of signifiant magnitude, so that these could then be subjected to careful visual inspection and ground down, if necessary, to determine their depths. Later effort would be directed toward the development, if feasible, of devices to automatically indicate the depth of drill pipe mill defects and to automatically reject those joints with rejectable defects. A highly important final program would be an extensive investigation of the relation of mill defects to drill pipe failures so that reliable and significant inspection standards based on the actual relation of mill defects to drill pipe failures might be established (to replace arbitrary standards based, for example, simply on the depth or extent of the defect).

● **Field inspection. Present inspection methods.** At the present time, a large proportion of the drill pipe in service has not been subjected to field inspection. In cases where field inspection is used, it is often limited to drill strings that have shown a record of excessive wash-outs and twist-offs during drilling.

Several field inspection services are now available and supply commercial inspection service at costs of the order of $1.00 to $3.00 per joint. The condition of drill pipe is often described by four approximate classes, the exact limits of which depend greatly upon the inspector's judgment and experience. Grade 1 drill pipe is considered to be in excellent condition and suitable for any type of drilling. Grade 2 pipe is in good condition and suitable for most drilling conditions. The quality of Grade 3 pipe is considered to be questionable, and the inspector does not guarantee that it will give reliable service under all drilling conditions. Occasionally, it is suggested that its use be restricted to top hole drilling only, or to conditions under which it is not subjected to severe stress, and where its failure will not cause unusual difficulties. Grade 4 pipe is considered to be definitely unfit for further service and should not be put back into the hole. There are no generally accepted standards classifying individual pipe defects definitely in one of the foregoing grades. The inspector bases his opinion on the general condition of the pipe, the extent of pitting, fatigue cracking, wear, thread conditions, and other considerations.

● **Visual inspection methods.** The most widely used field inspection method is the visual inspection of the outer surface, threads, shoulders, and, in many cases, the inner surface of the drill pipe. The surfaces to be inspected are usually



(a) Schematic arrangement of magnetizing coils to obtain a substantial longitudinal component of eddy current flow. In this assembly, the eddy currents cross cracks and washouts normally, revealing their presence by an increase in apparent resistance.

(b) Schematic arrangement of A.C. source, variable condenser tuned slightly off resonance when coil is placed over sound pipe, and vauum tube voltmeter. Insert shows variation of voltage across condenser as a function of effective inductance of coil (which changes when defects enter the eddy current path).

FIG. 9. Typical arrangement of components of eddy current test of used drill pipe. Several rectangular coils would be placed about the periphery of the pipe. Test could be applied automatically to pipe coming out of the hole on a trip.

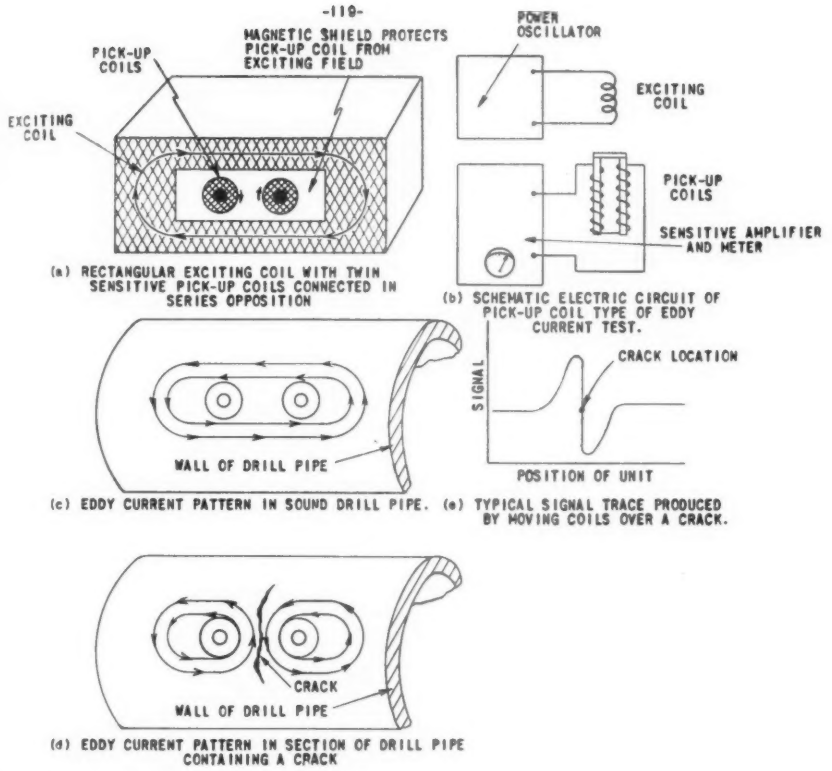

MAGNETIC SHIELD PROTECTS PICK-UP COIL FROM EXCITING FIELD
PICK-UP COILS
EXCITING COIL
(a) RECTANGULAR EXCITING COIL WITH TWIN SENSITIVE PICK-UP COILS CONNECTED IN SERIES OPPOSITION
POWER OSCILLATOR
EXCITING COIL
PICK-UP COILS
SENSITIVE AMPLIFIER AND METER
(b) SCHEMATIC ELECTRIC CIRCUIT OF PICK-UP COIL TYPE OF EDDY CURRENT TEST.
WALL OF DRILL PIPE
(c) EDDY CURRENT PATTERN IN SOUND DRILL PIPE.
SIGNAL
CRACK LOCATION
POSITION OF UNIT
(e) TYPICAL SIGNAL TRACE PRODUCED BY MOVING COILS OVER A CRACK.
CRACK
WALL OF DRILL PIPE
(d) EDDY CURRENT PATTERN IN SECTION OF DRILL PIPE CONTAINING A CRACK

FIG. 10. Typical pick-up coil eddy current nondestructive test. The pick-up coil is shielded from the direct magnetic field of the exciting coil. It responds only to variations in the magnetic field produced by eddy currents in the wall of the pipe.

sibly, sandblasting) with an air blast to remove the resultant material, particu- precleaned by wire brushing (or, pos- larly from the interior of the pipe. The interior of the pipe is usually examined by means of an illuminated tubescope or borescope. Questionable defects may be examined further by grinding down or by other techniques. The cleaning and examination are naturally time-consuming operations, and a reasonably skilled and experienced inspector is required for reliable results. Services of this type are commercially available in some large drilling fields[5]. The drill pipe must be laid down and racked for convenience in handling for visual inspection. These considerations limit the frequency with which careful visual inspection of drill strings can be accomplished. The resultant grading of the drill pipe must of necessity be conservative, for the prediction must be made of pipe performance for a period of perhaps three to six months in advance (or until the next inspection). For these reasons, control of drill pipe performance by visual inspection is by necessity expensive; however, it must be noted that certain parts of the inspection, such as inspection of threads, shoulder, and joints, are not particularly suited for methods other than visual inspection and visual checks with gages. Hence, alternative methods of inspection of the long uniform section of each joint would have to be accompanied by occasional visual inspection of the threads and similar features, regardless of the development of pipe inspection instruments. Such visual inspection would only be necessary at relatively long intervals, whereas automatic or instrument inspection might be performed as frequently as necessary to prevent drill-pipe failures in the hole.

● **Magnaflux inspection.** Magnetic particle inspection ("Magnaflux") has already been developed, in combination with visual inspection, into a commercial inspection service[6]. As with visual inspection, the drill pipe must ordinarily be laid down and racked and is usually cleaned by wire-brushing prior to examination. In the present field applications, the pipe is magnetized longitudinally by an external coil of relatively few turns, energized with direct current from a welding generator. (See Fig. 6.) The coil is moved along the joint while dry Magnaflux powder is applied beneath it. The inspector examines the Magnaflux patterns while the powder is being applied (in many field locations the powder is blown off the tube surface by wind almost immediately after the examination is completed). The Magnaflux particles reveal the location of cracks, seams, laps, and similar narrow-line defects that might otherwise be difficult to find by visual inspection. In this manner it should be possible to increase both the speed and the reliability and sensitivity of visual inspection of drill pipe in the field. Since Magnaflux does not reliably indicate the depth of deeper defects, it may be necessary to examine them further by grinding or other techniques. As with visual inspection, the evaluation of pipe quality is a matter of judgment and experience on the part of the inspector, who must be a reasonably skilled technician. The previously listed considerations of cost, frequency of inspection, and conservative standards apply to the Magnaflux visual inspection just as to ordinary visual inspection.

● **Gamma ray inspection.** A method of gamma ray inspection of drill pipe has been developed commercially[7] and appears to offer many advantages. Drill pipe is inspected from the inside by pulling through the joint an assembly containing a capsule of radioactive material, a lead barrier, and a sensitive Geiger counter to measure the secondary or refracted radiation from the wall of the pipe. (See Fig. 3a.) It is asserted that the device is sensitive enough to pick out and indicate holes, corrosion pittings, seams, grooves due to rough piercing, and even microscopic cracks along grain boundaries. It is believed that the device responds to local stress concentrations, regardless of their cause, and hence indicates not only defects that are stress raisers, but conditions of stress in the pipe resulting from misuse of tongs and slips or other overloading. The output signal from the Geiger counter is amplified, integrated, and used to produce a permanent record in a recording instrument. Such records are ordinarily made about 12 in. long for each 30-ft joint of drill pipe (See Fig. 7.) The records are obtained rapidly by pulling the measuring assembly through the joint at a rate of about 1 ft per sec. The indications are apparently unaffected by surface scale or corrosion products, so no prior cleaning is necessary. Inspection can therefore be made rapidly—a typical rate is about 250 joints per 8-hr day for each unit and crew. The costs are about one-third of those for visual inspection. The films are developed in the field as inspection proceeds, and the pipe is graded on the spot, but permanent records of each joint are available for future reference. Although such tests are now being made on drill pipe that has been racked, no special handling of the pipe is required. Possibly future developments will make possible the application of this method to drill pipe in the hole or while standing in the derrick during a trip.

● **Possible additional field inspection methods.** Other methods might be developed for the field inspection of drill pipe. Certain of these methods could be applied simply as aids to the visual inspector making careful periodic examinations. Other test methods might be applied to the detection of gross defects (incipient washouts and twistoffs) on the drill string as it was being pulled from the hole, while it was standing in the derrick, or while it was being lowered into the hole. The latter type of test would be fully automatic in its indications and would be used each time a trip was made.

[5]Tuboscope Company, Houston, Texas.

[6]American Inspection Company, Odessa, Texas; Tuboscope Company, Houston, Texas, and Ventura, California.

[7]The Electrograph Company, Oklahoma City, Oklahoma.

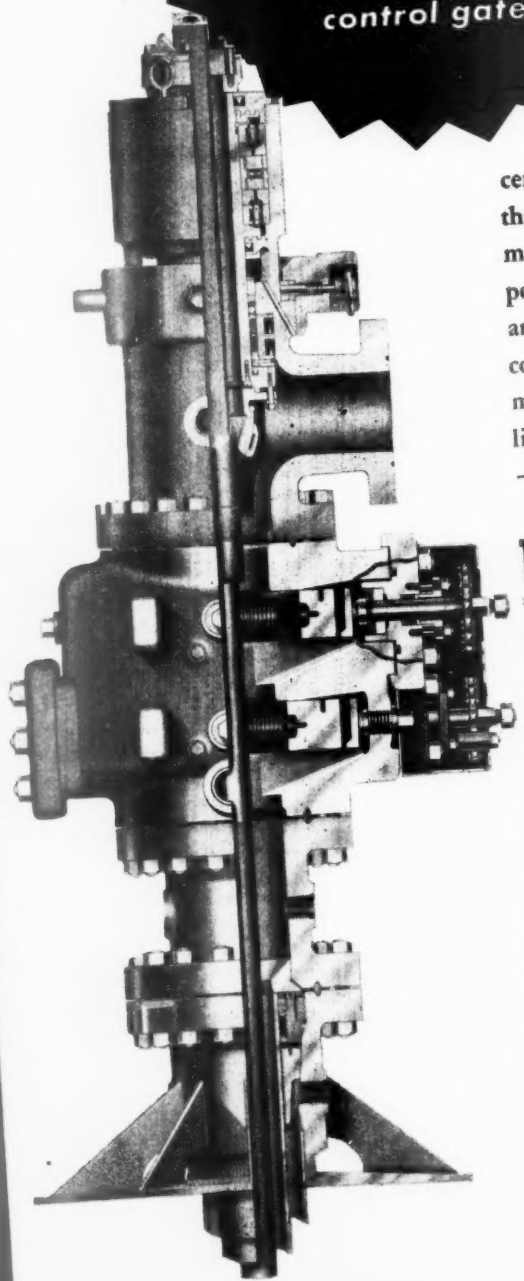
Your point-by-point guide to Co

Do you know the

10 VITAL FEATURES

to look for in a control gate?

only Shaffer has them all!

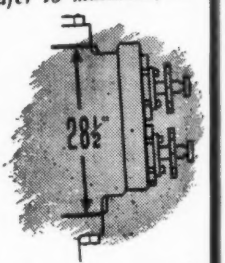


Typical modern control hook-up showing a Shaffer Type 45 Double Cellar Control Gate (center) *with a Shaffer Combination Landing Base Head* (bottom) *and a Shaffer Type 46 Combination Rotating Blow-Out Preventer and Stripper* (top).

WHEN YOU PURCHASE cellar control gate protection, make certain you get *completely modern* control equipment . . . equipment that not only offers the maximum in pressure protection, but also the maximum in space-saving compactness, in wide-range adaptability, in positive dependability, in maximum ease and speed of changing rams, and in still other important features that go to make up *complete* control gate efficiency. Before you buy *any* control gate equipment, make a point-by-point check against the 10 Shaffer advantages outlined here. *Only Shaffer — pioneer of modern control gate equipment — gives such complete superiority on every vital feature!*

1 Check ☑ COMPACTNESS!

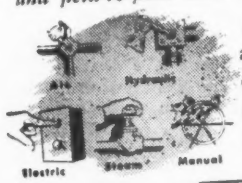
Space-saving compactness is vital. It means shallower cellars without sacrificing on cellar equipment — *and shallow cellars reduce installation costs, are easier and safer to maintain, cut costs in many ways throughout the life of the well.*



No other gate equals Shaffer compactness. *Two* single Shaffer Gates usually require the space of *one* ordinary drilling valve . . . and the Shaffer Double Gate *(two* separate ram assemblies unitized into *one* body) is so amazingly compact that — even in the largest sizes — it requires *less than 29"* in vertical height!

2 Check ☑ POWER ADAPTABILITY!

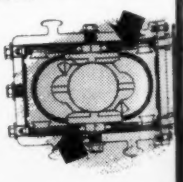
A control gate that can be operated with virtually any *type of power can be moved from rig-to-rig and field-to-field with maximum interchangeability and adaptability.*



Again Shaffer is unequalled. Shaffer Gates can be operated with virtually *any* type of power — air, hydraulic, electric or steam drives that are compact, foolproof and interchangeable. In addition, they have the vital protection of easy *manual* operation in emergencies.

3 Check ☑ POSITIVE DEPENDABILITY!

A control gate is emergency equipment. It must *operate at all times without risk of failure.*

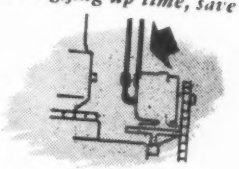


Shaffer dependability is unsurpassed. Shaffer Gates provide the proven dependability of foolproof *mechanical* drive. Their synchronized stainless steel operating screws are positive in action and hold the rams in absolute alignment. There is no risk of binding, no uncertainties in operation.

to Complete control gate efficiency

4 Check ☑ INSTALLATION SIMPLICITY! *Simple installation requirements save rigging up time, save space and give a cleaner, safer, more efficient cellar.*

Shaffer Gates are extremely simple to install. Only two quick pipe connections are required for air, hydraulic, or steam drives — just a single electric circuit for the electric motor drive. no cellar-clutter, no complicated piping, no space-wasting manifolding. Yet gate operation is completely centralized through *one* convenient control at the driller's fingertips!

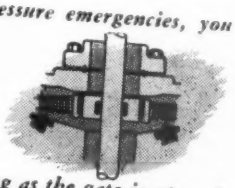


5 Check ☑ EASE OF CHANGING RAMS! *Quick, easy ram changes simplifies changing from one pipe size to another so that complete pressure protection can be maintained.*

Here again it's Shaffer. Just remove *one* end cover and the *complete* ram assembly — not just *half* of it — is readily removable for changing the rams. Change rams, replace one end cover, and the job's done. It's as quick and easy as that!

6 Check ☑ FOOLPROOF RAM POSITIONING! *In the excitement of pressure emergencies, you want a gate you can close — and have it stay closed without auxiliary locking devices or additional operations to remember about.*

Positive screw feed holds Shaffer rams solidly in whatever position they are set *without risk of "creeping."* No locking devices or secondary operations of any kind are needed!

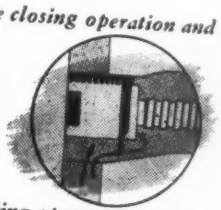


7 Check ☑ NON-DRAGGING RAMS! *Rams in which the sealing surfaces drag as the gate is opened or closed are harder to operate and rapidly lose their sealing efficiency through unnecessary wear on the sealing surfaces.*

Shaffer Gates have patented "floating rams" in which the surfaces that seal between rams and gate body remain retracted until the gate is closed — then expand *automatically* to form a pressure-tight seal. No wear — no drag — and the sealing surface is thus protected against damaging friction!

8 Check ☑ FULL UTILIZATION OF WELL PRESSURE — *both to assist in the closing operation and to increase the sealing efficiency after the rams are closed.*

Shaffer Gates are so designed that the well pressure flows below and behind the rams to balance any pressure on the face of the rams, thus insuring pressure-free closing. After the rams are closed, well pressure below the rams assists in sealing them even tighter as pressure increases. The higher the pressure the tighter Shaffer Gates seal — *automatically!*

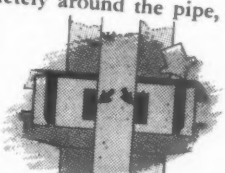


9 Check ☑ SELF-CLEANING DRAINAGE! *Because of the very nature of drilling operations, mud and sand cannot help but get into a control gate. So look for self-cleaning efficiency that assures free ram travel and smooth operation.*

Note how the entire bottom of Shaffer Gates is sharply sloped toward the well so that any mud and sand that DOES get into the gate quickly drains back out again. The rams travel on high narrow guide ribs that afford adequate support yet prevent mud and sand accumulation from interfering with free ram operation!

10 Check ☑ FOR COMPLETE PRESSURE SEAL! *For full pressure protection make certain that your control gate provides a tight leak-proof seal at all points where leakage might occur.*

Shaffer Gates give a complete pressure seal. When Shaffer Rams are closed, they not only seal against each other and completely around the pipe, but also seal in a complete circle against the upper inside face of the gate body. They not only close and hold against the highest pressures, but will safely hold extremely high pressures *indefinitely* after being closed!



Even these ten points of Shaffer superiority do not tell the *complete* Shaffer story of unequalled efficiency and safety. But they give some idea of the multiple advantages you get in Shaffer Control Gate Equipment. We invite you to check them against all other control gates. Then get the full details from our Shaffer representatives — or write direct.

SHAFFER

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See pages 3454 to 3506 of your 1947 Composite Catalog for helpful information on Shaffer equipment.

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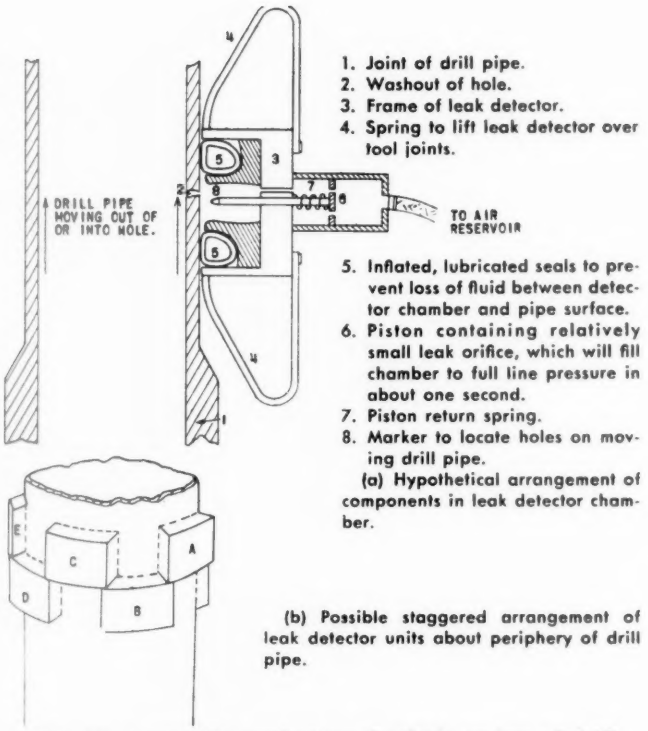

1. Joint of drill pipe.
2. Washout of hole.
3. Frame of leak detector.
4. Spring to lift leak detector over tool joints.
DRILL PIPE MOVING OUT OF OR INTO HOLE.
TO AIR RESERVOIR
5. Inflated, lubricated seals to prevent loss of fluid between detector chamber and pipe surface.
6. Piston containing relatively small leak orifice, which will fill chamber to full line pressure in about one second.
7. Piston return spring.
8. Marker to locate holes on moving drill pipe.
(a) Hypothetical arrangement of components in leak detector chamber.
(b) Possible staggered arrangement of leak detector units about periphery of drill pipe.

FIG. 11. A possible mechanism for leak testing of drill pipe. Assuming that the chamber can be sealed against leaks where it contacts the pipe surface (which is questionable), holes and washouts through the wall of the drill pipe allow high pressure air or liquid in the leak chamber to escape. This lowers the pressure in the chamber and the unbalanced pressure actuates the piston and marks the location of the defect on the drill pipe, ringing suitable alarms or operating recording devices. The marking continues until the leak has passed the chamber, in which pressure is then restored through the small leak orifice in the piston.

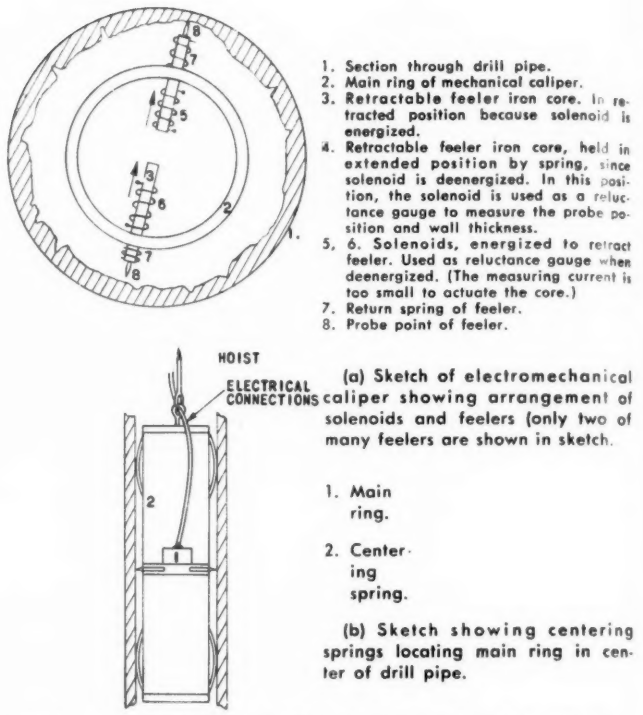

1. Section through drill pipe.
2. Main ring of mechanical caliper.
3. Retractable feeler iron core. In retracted position because solenoid is energized.
4. Retractable feeler iron core, held in extended position by spring, since solenoid is deenergized. In this position, the solenoid is used as a reluctance gauge to measure the probe position and wall thickness.
5, 6. Solenoids, energized to retract feeler. Used as reluctance gauge when deenergized. (The measuring current is too small to actuate the core.)
7. Return spring of feeler.
8. Probe point of feeler.
HOIST
ELECTRICAL CONNECTIONS
(a) Sketch of electromechanical caliper showing arrangement of solenoids and feelers (only two of many feelers are shown in sketch.
1. Main ring.
2. Centering spring.
(b) Sketch showing centering springs locating main ring in center of drill pipe.

FIG. 12. Sketch of a possible electro-mechanical caliper to measure the wall thickness, and the location and depth of pits and cracks in the interior of drill pipe.

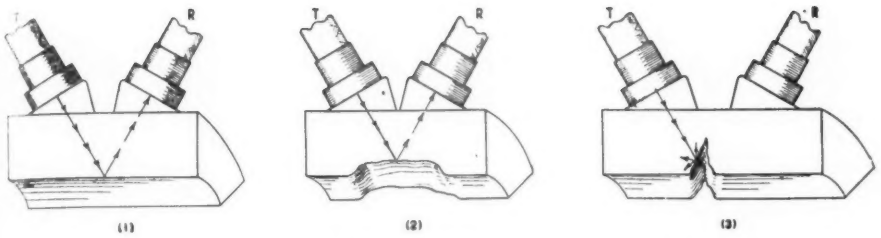
Finally, devices might possibly be found that would measure drill-pipe defects as the detector was lowered into the pipe in the hole. None of these proposed methods has yet been tried or developed in practical form, and extensive developments and tests might be expected to be necessary before such developments could be brought to practical success.

● **Electric current conduction tests.** Cracks and voids that pass part or all the way through the wall thickness could be detected reliably by electric current conduction tests, with suitable arrangements of electrodes and an appropriate detector. For sensitivity, each pair of current electrodes should provide current to only one-fourth of the circumference of the pipe. Multiple sets of electrodes, or rotation of the pipe under one set of electrodes, might be used to obtain complete coverage. Typical electrode arrangements are sketched in Fig. 8. Potential probes placed in suitable relation to the current electrodes would be used to detect variations in potential distribution caused by cracks. Small signals of this type are difficult to amplify and to record; however, if the method were sufficiently promising to warrant the expense of development, cracks and washouts could be indicated by recording meter, by indicating instrument, by alarm, or by paint marks on the pipe at the defect. The method could be used as a supplement to visual inspection, to determine the depth of cracks, but more promising application would be to the drilling rig itself. The detectors might be placed beneath the floor of the drilling rig, at the bell mouth of the hole, to inspect automatically the string as it was pulled from or lowered into the hole. The test would be sensitive only to gross cracks and to reductions in wall thickness due to corrosion. By keeping an automatically recorded trace of the signal from day to day, the rate of growth or progression of cracks could be determined, and those joints in which defects were progressing rapidly toward the point of failure could be removed from the string.

● **Eddy current induction tests.** Similar indications might be obtained by means of coils inducing a secondary flow of eddy currents in small closed loops in the wall of the drill pipe. Each coil would be arranged to produce current flow about a circuit in such a manner that the significant length of current path was normal to the ordinary circumferential fatigue failure and washout. (See Fig. 9a.) For sensitivity to small cracks, each coil should measure the properties of only a small area, say one-eighth of the cricumference of the drill pipe. Since the current density produced by induction is greatest at the wall surface nearest the exciting coil, and least at the opposite surface, such coils placed on the outside of drill pipe would be particularly sensitive to deep cracks progressing outward from the inner surface of the wall. The detectors can be made sensitive to changes in wall thickness due to deep pitting and general corrosion.

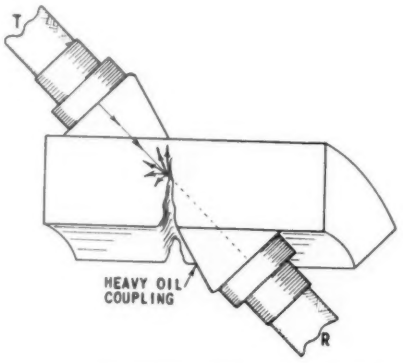
The simplest electric circuit for exciting the coils and indicating changes in the wall conductivity consists of an alternating current source exciting the coils through a resistance-capacitance circuit turned slightly off-resonance for the normal wall condition. Variations in wall thickness or discontinuities such as cracks and washouts would produce relatively large changes in current and in voltage across the external capacitor, which could be used as signals to operate recorders, relays, alarms, and other indicators. (See Fig. 9b.)

A more complicated alternative method is the provision of a separate pickup coil so arranged that under normal wall conditions no signal is produced by the primary exciting coil or by the eddy currents in the tube wall. The pickup is sensitive, however, to variations in the eddy current pattern produced by cracks and washouts. The pickup signal in an instrument of this type is relatively small, however, and requires sensitive amplifiers and well-regulated power supplies to obtain consistent and reliable operation. Such a system is sketched in Fig. 10.



(a) Possible methods of applying one-side supersonic detection tests to used drill pipe with cracks and pits.

1. Over unpitted pipe. The supersonic wave is reflected fully and at an angle corresponding to normal wall thickness.
2. Thin walls return the reflected wave to the surface closer to the transmitter, requiring a relative motion of the coupling blocks for maximum signal reception.
3. Cracks may interfere with the transmission of the transmitted or reflected waves, and so may be detected.
4. Rough pitting breaks up the reflected wave, reducing the signal level.



(b) Possible method of applying two-side supersonic detection test. Special means of coupling the receiving crystal to the pitted inner surface of the drill pipe would be required.

FIG. 13. Application of supersonic transmission and reflection methods to testing of used drill pipe.

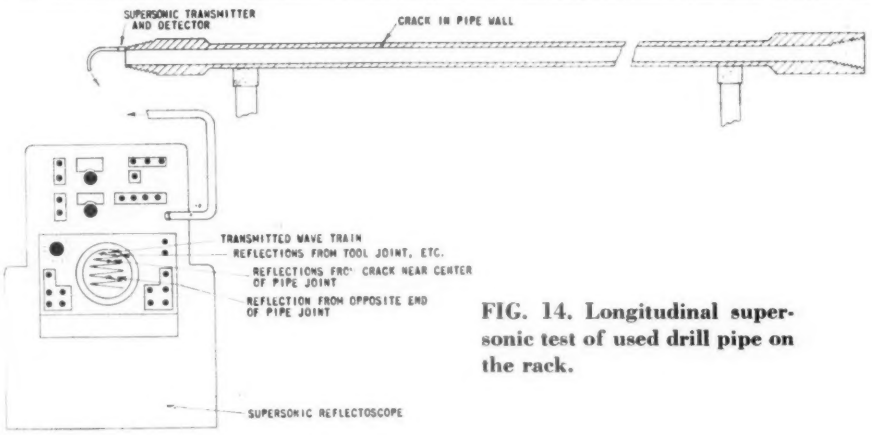
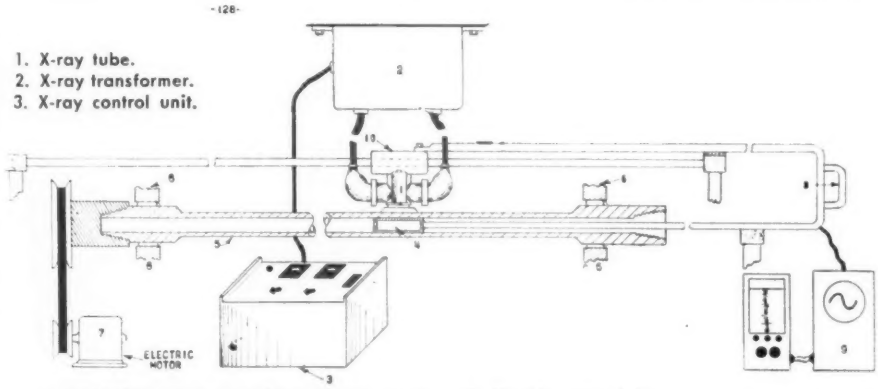

SUPERSONIC TRANSMITTER AND DETECTOR
CRACK IN PIPE WALL
TRANSMITTED WAVE TRAIN
REFLECTIONS FROM TOOL JOINT, ETC.
REFLECTIONS FRO' CRACK NEAR CENTER OF PIPE JOINT
REFLECTION FROM OPPOSITE END OF PIPE JOINT
SUPERSONIC REFLECTOSCOPE

FIG. 14. Longitudinal supersonic test of used drill pipe on the rack.



4. Ionization gauge or fluorescent screen-photocell X-ray detector.
5. Joint of drill pipe.
6. Bearings in which drill pipe rotates.
7. Electric motor drive.
8. Position control for X-ray tube and detector.
9. Meter to indicate transmitted X-ray intensity.
10. Sliding support for X-ray tube.

FIG. 15. X-ray transmission test for wall thinning and corrosion pitting in used drill pipe.

● **Air, liquid, and vacuum leak tests.** A reliable detector for cracks and washouts that pass completely through the wall of drill-pipe producing a passage for fluids or gases might be developed if suitable seals could be invented. A typical system is sketched in Fig. 11. A series of overlapping pressure chambers is designed to fit around the circumference of the drill pipe, and suitable unbalanced pressure or inflated seals (lubricated so that the drill pipe will pass easily through them without causing leakage of gas) are provided for each chamber. The entire assembly is arranged to open up so as to allow tool joints to pass through readily. Provision must be made to prevent excessive wear or damage to the seals. A means of removing the assembly quickly or otherwise permitting passage of the rock bit must be available. The chambers may be filled with air or liquid under moderate pressure, arranged so that leaks cause readily detectable drops in pressure or flow of the liquid. As washouts and cracks pass by the detection chambers, the flow variations would actuate recording or marking mechanisms to indicate the faults. The device could be mounted at the mouth of the well, and drill strings checked each trip.

An alternative device might be lowered through the drill-pipe in the hole and would serve to locate washouts. In this case, the pressure chamber and seals would be designed to fit the interior of the drill-pipe and to operate under mud pressure conditions present in the hole. A small cylinder of compressed or liquefied gas in the unit might supply pressure for the tests.

The feasibility of leak tests would depend upon the ingenuity of the designer and should be checked by practical tests at an early stage in the development.

● **Electromechanical caliper methods.** Cracks, corrosion pits, and incipient washouts on the inner surface of drill pipe might be detected and located by means of any of several calipering devices. A typical device, sketched in Fig. 12, consists of an assembly to be lowered into drill pipe in the hole, or to be drawn through drill pipe on a rack. A main ring, centered in the pipe by long leaf springs bearing against the inner surface of the pipe, carries a series of retractable feelers or prongs, arranged radially so as to contact the inner surface of the pipe at a series of points along a circumferential ring. The feelers may be pushed outward to contact the tube surface and withdrawn between measurements by quick-acting magnetic or pneumatic motors. The maximum outward displacement of each feeler is recorded by an attached slide wire resistance or other electrical device that transmits the deflection signal to a multichannel recorder. Local pits and wall thinning are revealed by variations in the deflection record for the feelers in contact with the defects. Cracks and washouts are similarly revealed by large deflections, particularly when they extend far enough to be recorded by several feelers. The feelers are fully retracted at the end of each measurement,

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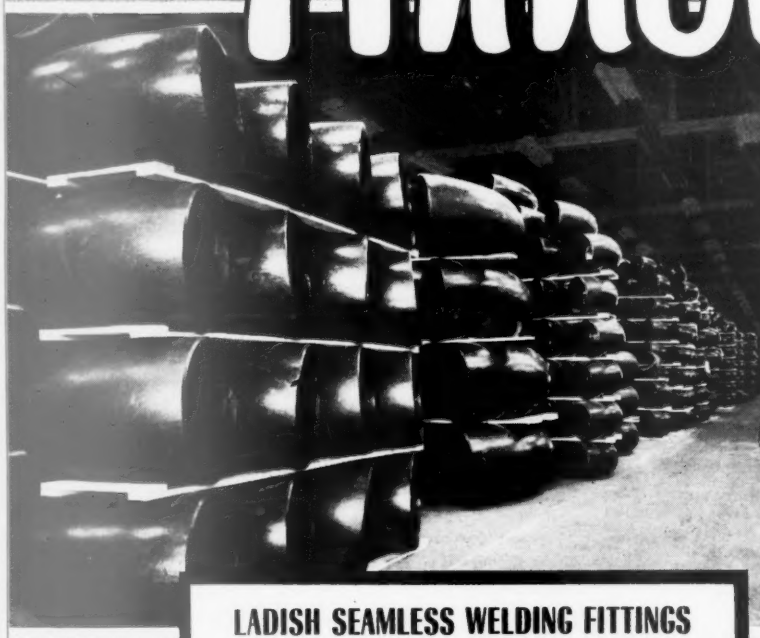
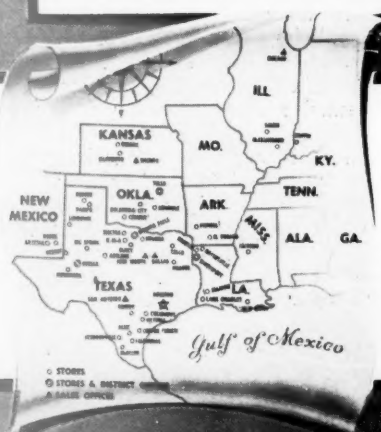


LADISH SEAMLESS WELDING FITTINGS

LADISH FORGED STEEL FLANGES

LADISH FORGED STEEL FITTINGS



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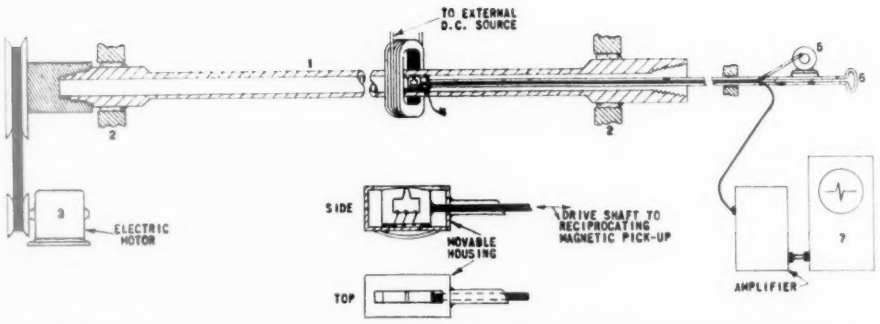


1. Joint of drill pipe.
2. Bearings in which pipe rotates.
3. Electric motor drive.
4. Sensitive magnetic pick-up (see Fig. 19).
5. Motor-driven cam to oscillate pick-up back and forth longitudinally: 3/16 in.
6. Position control for insertion unit. (Could be motorized.)
7. Oscillograph revealing signal of defects. Auxiliary equipment to mark pipe and record defects is not shown.

FIG. 16. Application of sensitive magnetic pick-up to inspection of drill pipe. Compare Fig. 2.

so that the motion of the main ring along the length of the drill pipe will not cause the feelers to be bent or broken off. Measurements should be taken every few hundredths of an inch, so that fine cracks could be detected. The displacement of each feeler at each measurement might be recorded on multichannel recorders, or the largest indication, or the average of several large indications, recorded. A preferable procedure might be to have the device actuate a suitable alarm or identify objectionable defects by paint marks.

● **Supersonic reflection and transmission methods.** The gross nature and thickness of fatigue cracks and corrosion pits in used drill pipe provide a good opportunity for their detection by means of supersonic waves. Several arrangements of transmitter and detector are possible (see sketches in Fig. 13). In most of these arrangements, both cracks and wall thinning due to corrosion pits could be detected and recorded; however, the rough, irregular surfaces of these defects tend to prevent sharp reflection signals, and several difficulties would have to be overcome in the development of a reliable test. The longitudinal test indicated in Fig. 14 could be used to determine the distance of large radial fatigue cracks and washouts from the end of a joint and might be used for a fast rough check of drill-pipe laid down on a rack, without necessity for handling of the pipe. Such a test might also be modified for use on each joint as the string was pulled from the hole. Commercially available supersonic testing equipment would be suitable in wave length for this application. The various transverse arrangements shown in Figs. 5 and 13 would be more feasible if higher wave lengths than are now commercially available could be used in testing. Most of these methods could be modified for use on drill strings making a trip, or for use on pipe laid down in a rack. For each method, the defects could be indicated by recording meters, by alarms, or by paint marks on the pipe.

● **X-ray transmission tests.** Wall thinning due to excessive corrosion pitting, and large area cracks, pinholes, and washouts may be detected sensitively by X-ray transmission. In these tests, X-rays produced on one side of the pipe wall pass through the wall and excite a sensitive ionization gage or equivalent radiation detector on the opposite side of the pipe wall. Wall thinning and large area cracks and holes through the wall result in increased X-ray transmission and increased response by the X-ray detector. This measurement may be interfered with to some extent by the presence of the products of corrosion, which also influence the X-ray transmission. It appears probable that this method would be feasible at highest sensitivity only for tests of joints laid down and scanned by a suitable pipe-handling machine carrying the testing equipment (Fig. 15).

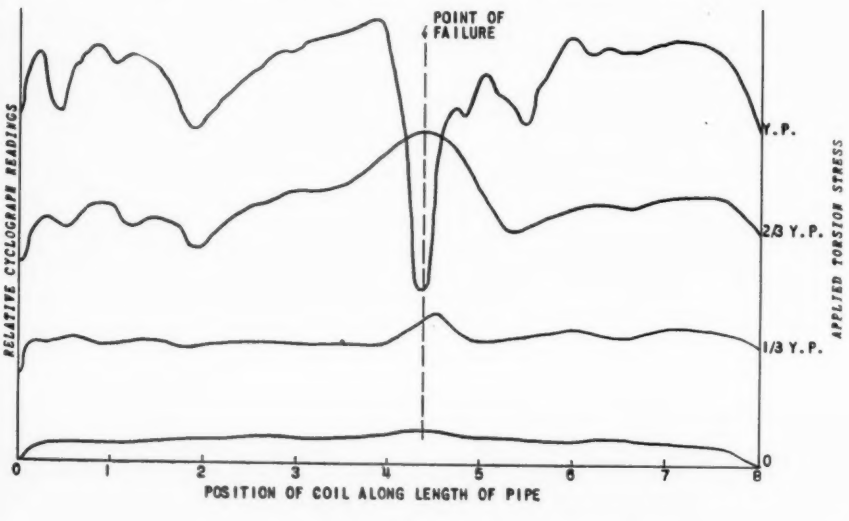
● **Surface magnetic field measurements.** The surface magnetic field measurement method described under mill tests (Fig. 2) might be modified for use in field tests of used drill pipe. The pickup unit would be caused to oscillate along the length of the drill pipe (about ¼-in. throw) while the pipe was rotated and the pickup moved along the joint, as sketched in Fig. 16. In this way, circumferential cracks would be recorded, and suitable paint marks could be made on the joint as desired to locate the defects. Like the X-ray tests, this method could be made rapid if scanning could be carried out by a suitable pipe-handling machine carrying the testing equipment.

● **DuMont cyclograph test method.*** The Du Mont Cyclograph (Fig. 17) has been used to conduct a series of laboratory and field tests on oil well drill pipe,

*The following information and data on the Cyclograph were supplied to Battelle Memorial Institute for use in connection with the project on drill pipe research, through the courtesy of the Allen B. Du Mont Laboratories, Inc. The Allen B. Du Mont Laboratories have made a Cyclograph unit available to Battelle Memorial Institute which can be used on this project. Further development of Cyclograph tests of drill pipe is planned in cooperation with the Du Mont Laboratories.

FIG. 17. Standard Cyclograph used in laboratory tests of drill pipe.

FIG. 18. Cyclograph record of joint of 5-in. drill pipe under torsion load (4 kilocycle test frequency).



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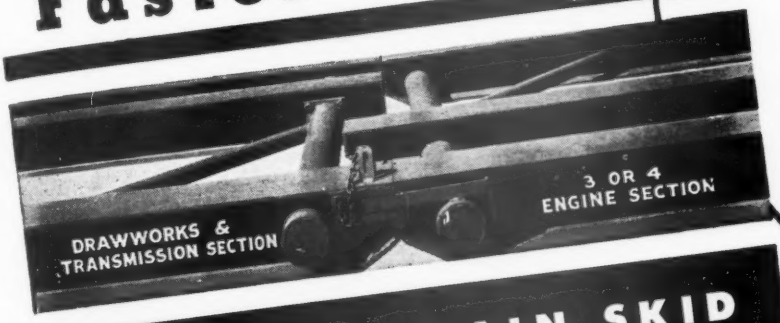

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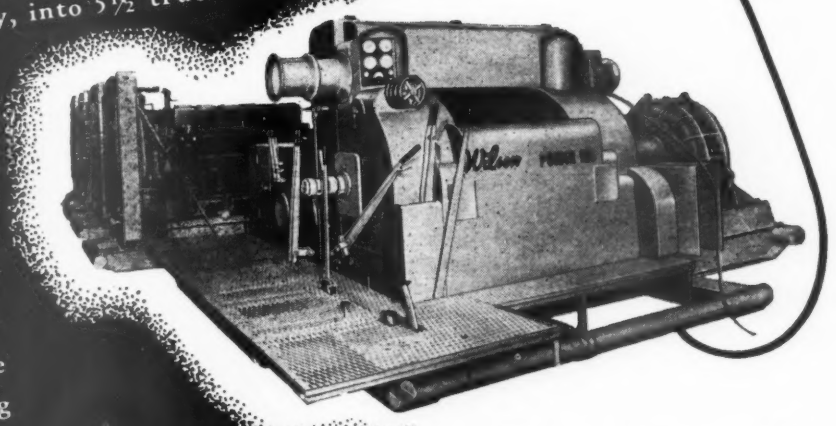

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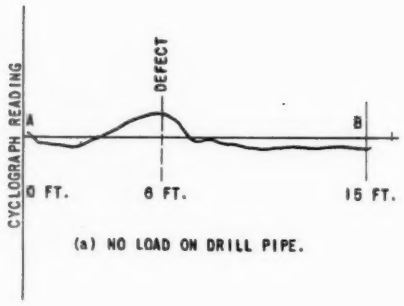

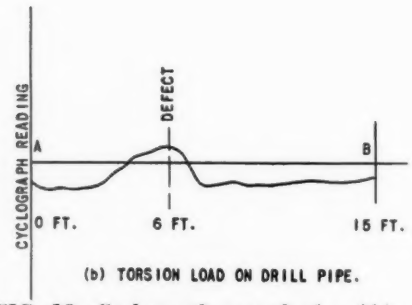

FIG. 19. Cyclograph record of a 4½-in. O.D. drill pipe which had been straightened at a point ft from one end.

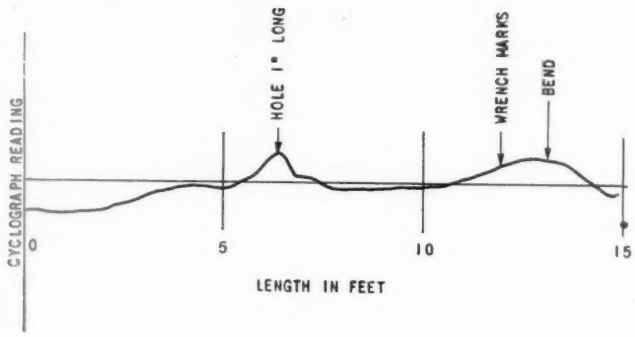

FIG. 20. Cyclograph readings for a joint of 4½-in. drill pipe containing a hole through the wall (about 1 in. in length), heavy wrench marks, and a slight bend.

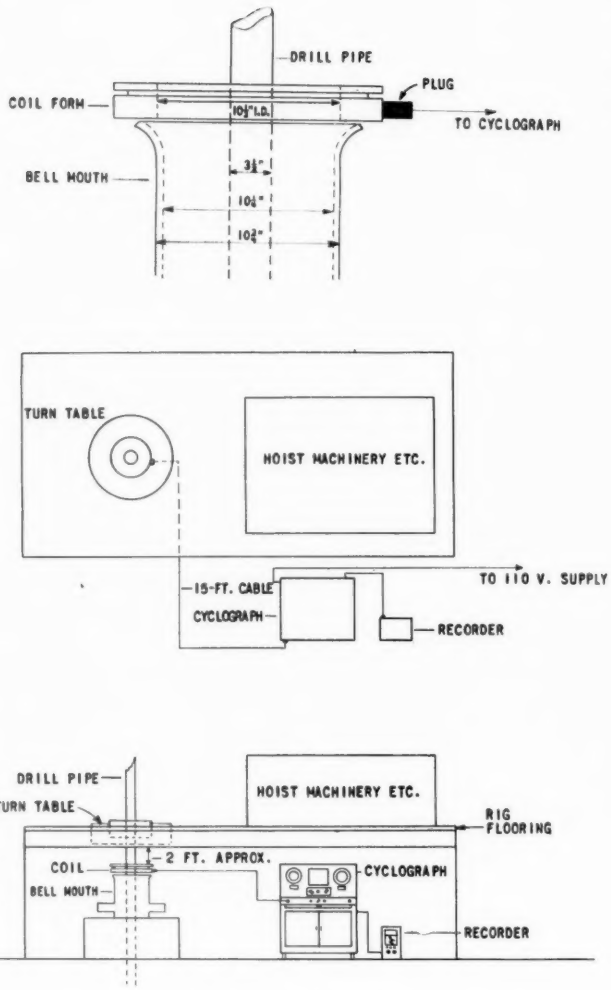

FIG. 21. Application of Cyclograph to drilling rig. Continuous readings were obtained as a 3000-ft drill string was pulled from the hole.

to examine the possibility of providing a practical test instrument for prediction of fatigue failure. Laboratory tests on a length of drill pipe while under various torsion loads indicated that any point on the pipe that had exceeded the elastic limit was detected by a sharp increase in core loss (Fig. 18). A section of drill pipe that had failed in service was tested, and it was found that an increase in core losses could be detected at some distance from the actual break. The increase was quite marked and was significant long before the Cyclograph coil reached the point where the actual deformation took place. Lengths of drill pipe were loaded to failure in torsion and checked by Cyclograph before and after failure, with results indicating that field tests would be worthwhile.

Field tests were made on the property of Eltex Limited, Spring, Texas. Preliminary tests of a joint that had been straightened showed a marked increase in Cyclograph reading when the coil was passed over the region that had been cold worked (Fig. 19). A half-joint with a hole about 1 in. in length through the wall gave very little indication of the hole, while a small increase in core loss was observed at a bend (Fig. 20). Further tests were made by continuously recording Cyclograph reading on a string of drill pipe as it was pulled out of the drill hole. The Cyclograph coil was clamped in position on top of the bell-mouth casing immediately below the rig floor (Fig. 21). Continuous readings were recorded for the three-thousand-foot string of drill pipe (Fig. 22). The average level of Cyclograph readings showed a gradual lowering as the string was pulled out, due to a decrease in total tension load with decreasing string weight and drag. A quick increase in drag on the string while pulling out showed as a definite rise on the recording curve. The sensitivity used on this test was too low to obtain the desired information on defects, and the coil setup was far from ideal. The recorded curves indicated primarily the gradual change in tension of the drill-pipe string. Because of the stationary position of the coil, the horizontal swing of the pipe as it moved through the coil varied the Cyclograph reading in a fairly regular manner, showing up as a ripple on the curve.

As yet, insufficient work has been done on drill pipe in service and a great deal of information must be collected, using a more sensitive instrument than has been tried so far. With this in mind, Du Mont has designed and built a new improved instrument operating on the Cyclograph principle (Fig. 23). This new instrument has the following advantages over the Cyclograph; increased sensitivity, portability, and construction in the form of a main unit and a remote oscillator unit that can be cable connected up to a distance of 500 ft, enabling the instrument to be set well away from the drill rig. For future field tests, a different design of coil assembly is necessary, and the ideal would be a coil that follows closely the swing of

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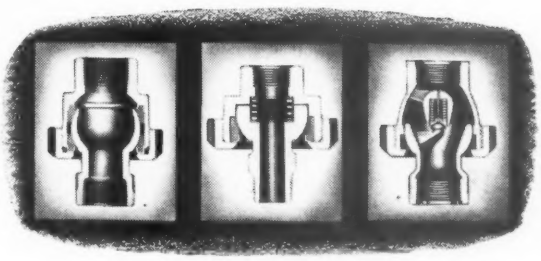

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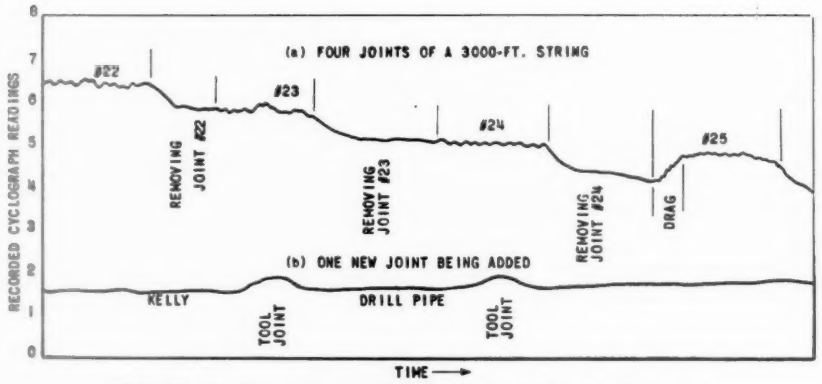

FIG. 22. Cyclograph records of string of 3½-in. diameter drill pipe pulling out of hole. Joints approximately 60 ft long, 10½-in. diameter stationary test coil of 3 Kc.

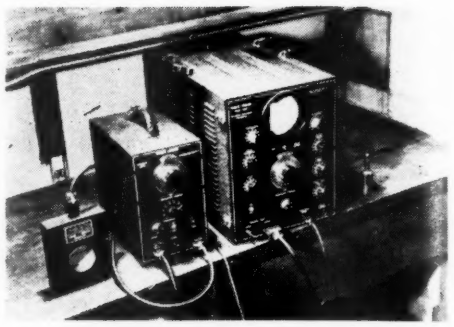

FIG. 23. New type Du Mont Cyclograph unit, showing main unit, remote oscillator, and coil plugged in.

the pipe string in a horizontal direction to eliminate the ripple this produces. If possible, this coil assembly should pass a drill bit both coming and going without the necessity of disconnecting the cord to the attached apparatus or moving the coil assembly from position.

It was concluded that results on field tests of a moving string of drill pipe look promising and warrant further work in this direction with an improved Cyclograph model. Testing drill pipe at the mill has not been investigated but might have possibilities using an inside test coil. Testing drill pipe on storage racks appears to present too many handling difficulties and would require a mechanized handling equipment, as well as a method of loading the pipe, to be efficient.

● **Suggested procedure for developing improved methods for field inspection of used drill pipe.** The most useful procedure for the investigation of methods of improving the field inspection of drill pipe appears to lie in (1) the development of automatic inspection devices to detect gross defects (such devices to be used on drilling rigs to inspect the drill string each trip and reject joints liable to fail before the succeeding trip), (2) the improvement of methods now commercially available for field testing (to avoid excessive development costs and time delays in obtaining production units), and (3) the development of other possible methods previously listed. The development of aids to the visual inspector of drill pipe, particularly methods of determining the depth of cracks, will be considered incidentally in connection with the basic program.

The methods of automatically detecting and indicating gross defects, whose application to drill pipe has already received some investigation by commercial interests, are the Cyclograph (electromagnetic loss measurement) and the Electrograph (back reflection gamma ray measurement). Both of these methods produce automatic records, claimed to be indications of the state of stress in the drill pipe. They are relatively less sensitive to holes and cracks as such. Each might be adapted for use inside or outside drill pipe, and apparently both are improved in operation if the drill pipe is stressed during testing. It appears probable that each might be modified for use (a) below the floor of the drilling rig, to check drill pipe as it is pulled from the hole, and (b) with a detection unit that might be lowered through the pipe in the hole. In each case, it is yet to be proved that the indications correspond to the pipe conditions which predict imminent fatigue failure in the hole. Therefore, careful field tests on drilling rigs under conditions where drill-pipe failures occur frequently, and modifications to improve the sensitivity and reliability of the tests, are in order. The necessary information and development could be obtained most quickly by cooperative field tests sponsored by the commercial interests and the American Association of Oilwell Drilling Contractors, and carried out by engineers of Battelle Memorial Institute as part of this research program.

The supersonic test method has also received extensive commercial development, but apparently has not been applied to drill pipe. Early field tests of this method, using commercial supersonic equipment modified for the purpose, would appear to be justified, particularly since this method is as adaptable as those previously recommended, and since its indications are directly correlated with the flaws in drill pipe, rather than the state of stress. The most effective procedure would probably be the modification of commercially available supersonic equipment in the laboratory by Battelle engineers, to obtain reliable indication of drill-pipe defects, followed by field tests on drilling rigs in regions where drill-pipe failures occur frequently.

The other possible methods listed, namely, electric current conduction tests, leak tests, and caliper tests, should be considered as alternatives and given preliminary laboratory development and check tests before more expensive development or field tests are undertaken. Similarly, methods of aiding the visual inspector in long-term field inspection should receive careful investigatoin in the laboratory before field tests are recommended.

● **Conclusions.** The preceding survey of possible methods of nondestructively inspecting drill pipe leads to the following tentative conclusions:

1. The mill inspection of new drill pipe for seams, laps, plug cuts, and other mill defects is essentially a separate problem requiring different equipment and test methods from those applicable to the field inspection of used drill pipe that has been subject to corrosion and to fatigue.

2. The most promising mill inspection methods appear to be those in which the drill pipe is scanned auotmatically and all defects located and suitably marked to bring them to the inspectors' attention. The final acceptance or rejection would be based on the decision of skilled inspectors, using sensitive inspection devices to supplement visual inspection.

3. The most promising field inspection methods appear to be those in which the drill string is automatically inspected, during each trip out of the hole, for incipient washouts and fatigue cracks likely to cause failure in the hole prior to the next trip. Dangerous defects would be prominently marked on the pipe, and an alarm would notify the crew of the drilling rig that the joint should be removed from the drill string.

4. The most useful improvement in long-range field inspection, in which the drill pipe is laid down on a rack and inspected carefully, appears to be the development of automatic scanning devices that would locate and mark each defect for the inspectors' attention and devices that would indicate the depth of defects. These developments would probably be expensive and would require pipe-handling machines.

4. Extensive developments of sensitive mill and long-range field inspection methods and equipment for drill-pipe inspection should only be carried out after a careful correlation of drill-pipe defects with extensive physical tests and service records, to establish rational limits for rejection of defects. There is no value in developing sensitive tests that reject drill pipe for defects that have no influence upon its performance or its operaitng life. ★★★

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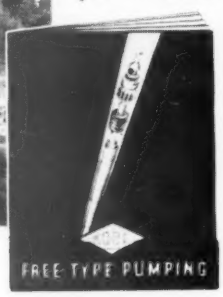

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GREATEST ADVANCEMENT IN OIL FIELD PRACTICE SINCE ROTARY DRILLING

Desalting crude oil

By W. A. BONAWITZ, N. A. KONEMAN, and M. C. HOPKINS,
Pan American Refining Corporation

● **Introduction.** The difficulties caused by salt in the crudes charged to No. 2 cracking unit at Pan American Refining Corporation, Texas City, Texas, became apparent soon after the unit was first brought on stream in January, 1937. This unit employs a combination of visbreaking and gas oil cracking. Salt fouling of the crude preheat exchangers and visbreaker once-through furnace coils was observed during the latter part of 1937 and appeared periodically afterwards, especially during the winter months. It was not until late 1943, however, that the salt problem reached serious proportions and necessitated a thorough study.

EXCLUSIVE

The charging of high-salt crudes to No. 2 cracking unit affects the unit in various and progressively serious ways. Initially, the salt begins to deposit out of the crude into the tubes of the crude preheat exchangers, which reduces the preheat duty on these exchangers and also increases the pressure drop, making it necessary to bypass the fouled exchangers. The salt deposition continues in this manner along the battery of preheat exchangers and soon requires a continual reduction in crude throughput in order to maintain adequate crude preheat to the crude flash tower.

An appreciable amount of the salt in the crude that does not deposit in the tubes is carried along into the crude flash tower. Here the virgin products are flashed off, including some acid formed by the decomposition of the salts. The resulting corrosion problem is controlled by the continuous addition of aqueous ammonia to the overhead. The remaining salt drops into the tower bottoms (reduced crude), which is then charged to the visbreaker once-through furnace coils. Here part of the remaining salt deposits out on the furnace tubes and apparently catalyzes the formation of coke. This consequently reduces the heat transfer and causes severe localized heating of the tubes with eventual sagging and rupturing. Also, this fouling of the visbreaker once-through tubes causes excessive inlet pressure. The visbroken reduced crude is then charged to the visbreaker evaporator and bubble tower where the corrosion effect caused by the decomposition of salt is again encountered in the overhead and treated with aqueous ammonia.

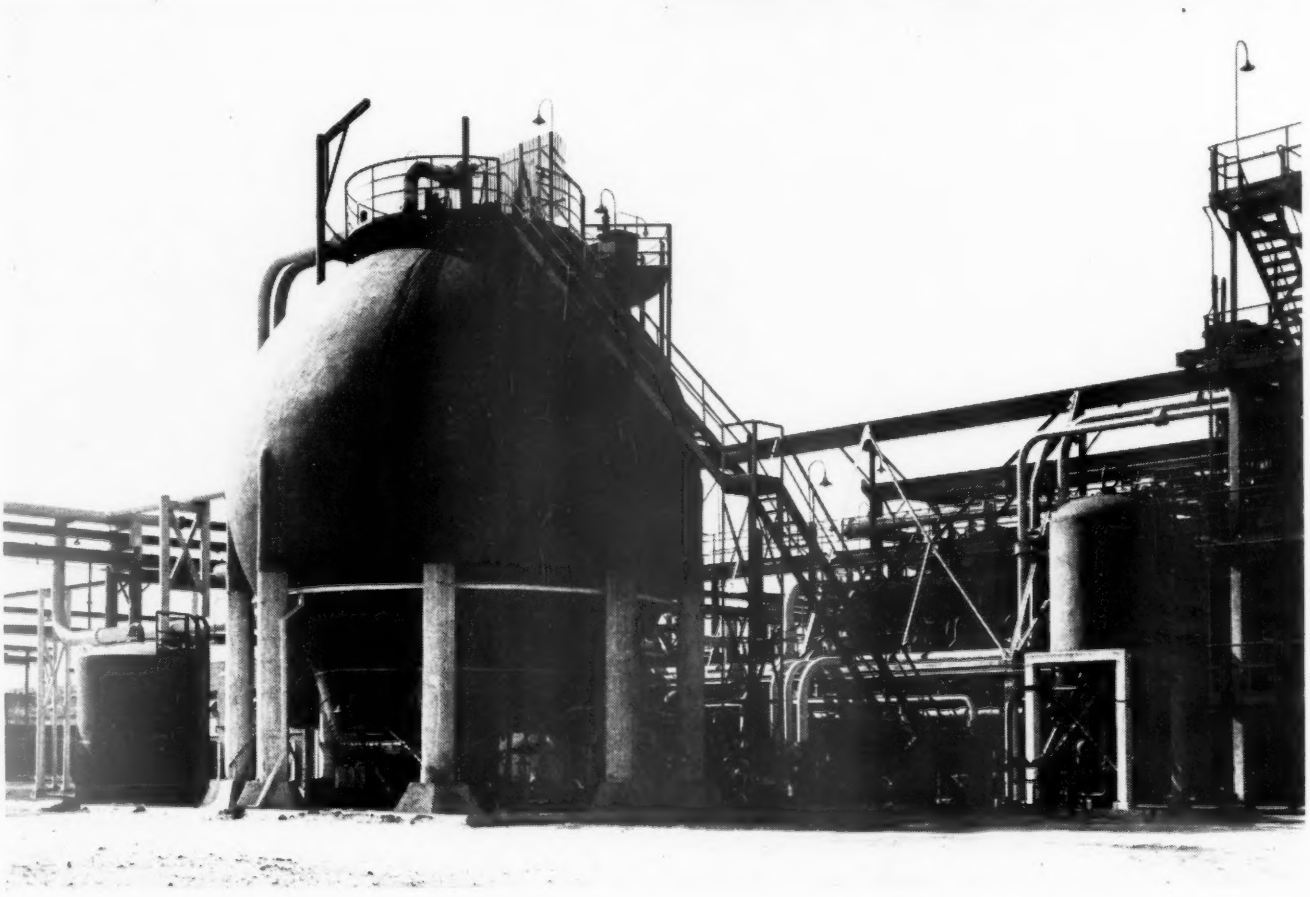
To summarize the effect of salt in the crude and the resulting necessary changes in operation:

(1). The loss of crude preheat makes necessary the reduction of crude throughput in order to maintain adequate preheat temperature. Also, operation at a minimum preheat temperature decreases fractionation efficiency and is particularly noticeable in the quality of the virgin gas oil produced.

(2). The quantity of reduced crude is decreased, which requires a reduction in visbreaker once-through charge rate.

(3). Salt and coke formation in the

View of Electrosphere, a caustic drum on the left, which is not being used, and the hot added-water drum on the right. A sampling header is beneath sphere in foreground. End of the surge drum can be seen behind and to the left of Electrosphere. Special desalting transformers are on top of Electrosphere.



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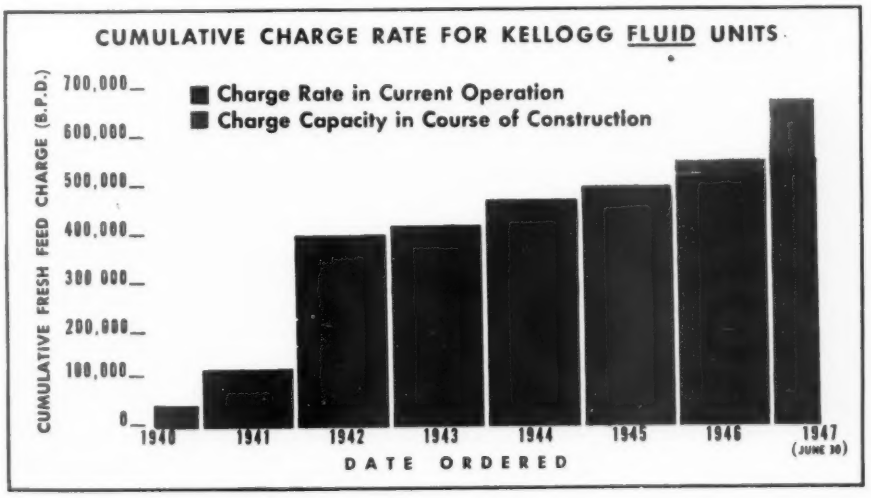

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visbreaker once-through furnace tubes cause excessive inlet pressures, overheating and sagging of the tubes, and make it necessary to reduce the transfer line temperature.

(4). The crack per pass is reduced on the once-through coils and the visbreaker tar gravity is accordingly increased with the reduction in once-through transfer line temperature.

(5). The overall effects of excessive salt in the crude are: Low crude rate and short runs with excessive down time and high labor costs, more frequent equipment replacements due to corrosion, and excessive strain on equipment.

A thorough study of this salt fouling problem was undertaken in 1944 and included: (1) A survey of salt bearing crude receipts, (2) the estimation of the salt tolerance of all three cracking units at Pan American, (3) the feasibility of field desalting of Hastings crude and the segregation of crude receipts to permit longer settling time for high-salt crudes, and (4) a review of existing desalting processes and techniques for possible application to the cracking units.

The salt content of Hastings crude continued to increase, and in 1945 a re-evaluation of the salt problem was made. This study pointed out the increasing severity of salt fouling and the economic penalties due to reduced crude rates, shorter runs, and decreased severity of visbreaking due to salt. It was concluded at this time that the economic penalties warranted installation of desalting equipment at Pan American's No. 2 cracking unit.

It was concluded that the Petreco Electric Desalting process of the Petroleum Rectifying Company offered the most advantages, including efficient and consistent desalting at a minimum of operational control and labor. An added consideration was the fact that two small Petreco electrical desalters had been in efficient service on Cayuga crude at No. 2 pipe still and an appreciable advantage on royalty rates would be effected. Also, if Petreco electrical desalters would be installed at cracking units Nos. 1 and 3, additional savings in royalties would be made as a result of higher throughput getting into lower rate brackets.

As a temporary measure to reduce the salt content of the crude while the Petreco unit was in the process of being constructed, additional and improved chemical desalting was begun in the Hastings field on September 3, 1945. This gave some relief; however, apparently slugs of high-salt crude affected the unit adversely and in the overall picture, field desalting did not offer the improvement expected. It was discontinued March 20, 1946, when the refinery desalting installation was placed in service.

TABLE I. Petreco pilot plant data. Desalting of Hastings and Mixed Coastal crudes.

Crudes:	Crude designation — Mixed Coastal	Hasting
Water and sediment, per cent (by centrifuge)	0.05	0.05
API gravity	38.3	31.3
Salt, ptb NaCl*	20.6	22.5
Added water designation	Well water	Well water
Emulsion, per cent water	15	15
Treating temp., F	190	190
Expected flow rate	Normal	Normal
Desalted crude:		
Water and sediment, per cent (by centrifuge)	0.08	0.1
Salt, ptb NaCl	0.8	1.8
Effluent brine, pH	8.7	8.3
Salt, ptb NaCl	565	575
Sludging tendency	Nil	Nil
Salt removal, per cent	96.0	92.1

*ptb NaCl=Total chlorides expressed as pounds of sodium chloride per 1000 bbl of oil. To convert to grams of salt per bbl (42 gal) of oil, multiply ptb by 0.453.

TABLE 2. Petreco pilot plant data. Processing tank bottoms and added water investigation.

A. Crude inspection

Designation	API gravity	W. & Sed., per cent	Salt, ptb Nacl
Charge to No. 2 C.U.	31.3	0.11	26.3
Tank bottoms, No. 2 C.U.	30.5	10.0	1565

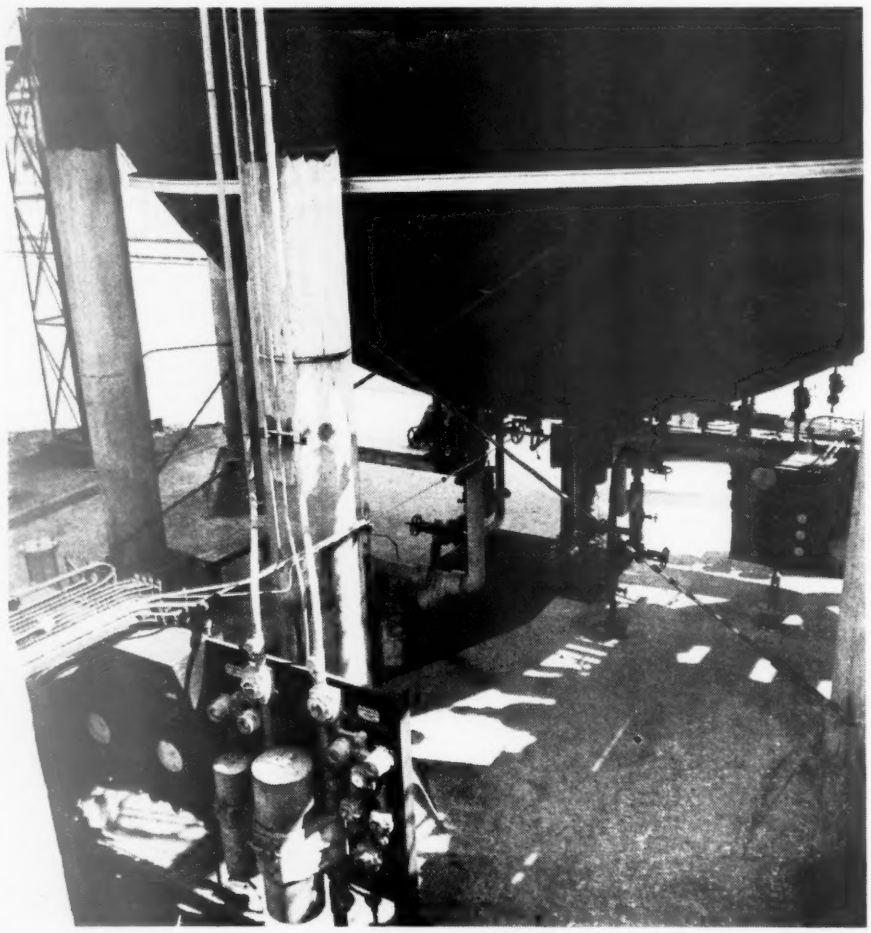
B. Desalting data

Composition of charge	Water used	Emulsion, per cent water	Salt, ptb NaCl — In	Salt, ptb NaCl — Out	W. & Sed., per cent — In	W. & Sed., per cent — Out
100% No. 2 C.U.	No. 2 tower	15	26.3	1.9	0.11	0.09
95% No. 2 C.U.+5% No. 2 Tank btms.	No. 2 tower	15.7	165	1.3	0.7	0.06

C. Water analysis

Designation	Well water	No. 2 cooling tower
Color	Clear	Greenish
Turbidity	None	Slight
Dissolved solids, ptb.	640	1450
Total chloride, expressed as NaCl, ptb.	460	1110
Sulphides, expressed as H_2S, ptb.	None	None
Calcium, expressed as Ca, ptb.	8.8	20.2
Magnesium, expressed as Mg, ptb.	3.5	9.1
Sulphate, expressed as SO_3, ptb.	None	2.8
pH	8.2	8.6
Alkalinity, to pH 8.3, expressed as $CaCO_3$, ptb.	0	8.8
Alkalinity, pH 8.3 to 4.3, expressed as $CaCO_3$, ptb.	112	414

At the bottom of the Electrosphere are two control panels. The surge drum is immediately to the right and is not shown. The top of the waste water fountain can be seen on the right, above the control panel in the foreground.



● **Installation of the electric desalter.** The decision on the installation of the Petreco unit was preceded by tests made by Petroleum Rectifying Company. Samples of crudes charged to No. 2 cracking unit were submitted to Petreco for laboratory examination to determine the expected performance of the Petreco desalting unit. These samples of Hastings and Mixed Coastal crudes were subjected to pilot plant tests in May, 1944. The data obtained from these initial experiments are summarized in Table 1. Analytical examinations of samples of crude oil and water were made. From the results of these tests it was concluded that, despite the high salinity of the added water (Table 2, Part C), excellent desalting should result from the Petreco process.

In June, 1944, samples of the charge to No. 2 cracking unit were studied to learn the effect of the metering of small amounts of tank settlings into the crude stream ahead of the desalter. Routine de-

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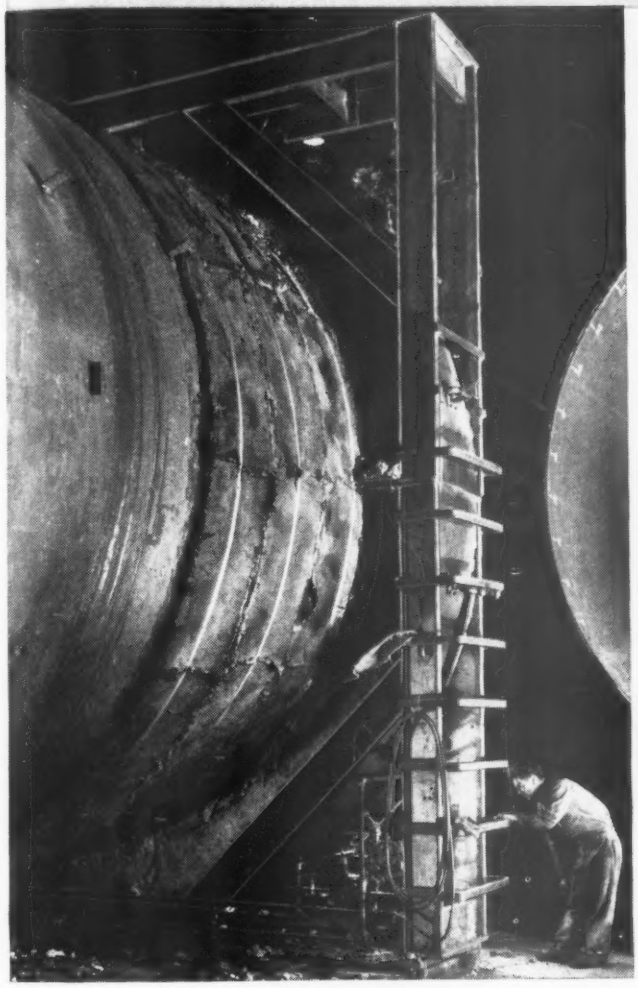

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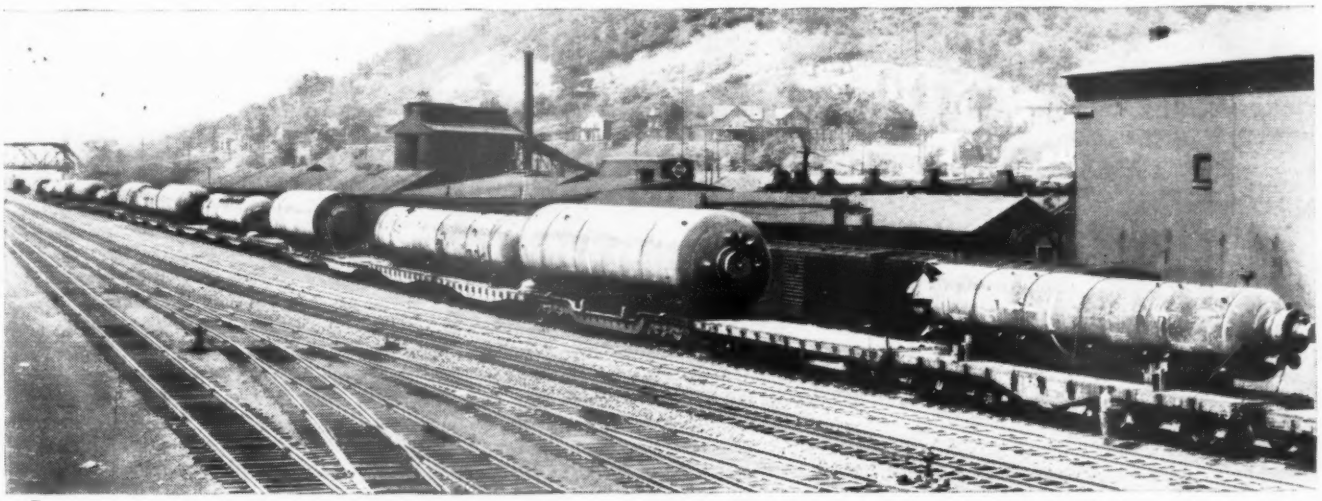


salting tests were made first on straight crude, then upon a charge containing 5 per cent tank settlings. The results of these tests are summarized in parts A and B of Table 2. These data indicate that a crude stream that has been blended with small quantities of tank settlings could be processed successfully by the Petreco unit, and that the vexing problem of accumulated tank bottoms could be mitigated.

Tests to ascertain whether cooling tower water could be successfully used in the process were also made. Part C of Table 2 gives the pertinent data concerning well water and No. 2 cooling tower water. The results from these tests were promising, for they indicated few deleterious effects from substituting the more plentiful cooling tower waters for fresh well water.

Because of recent improvements in Petreco electrode design, it was suggested by engineers of that company that the water-oil ratio of 15 per cent employed in previous tests (Tables 1 and 2) might be reduced. This possibility was confirmed by tests made in May, 1945; and it was indicated that adequate salt removal could be expected if as little as 5 per cent added water were used.

After evaluating the laboratory test data, Pan American and Petreco established a desalting plant location and discussed a preliminary piping layout. With this information Petreco submitted a plant proposal.

Desalting equipment was to be one 36-ft diam sphere, with the necessary special electrical and mechanical accessories, designed to desalt 45,000 bbl a day of crude. The desalter was designed on the premise that the crude would be delivered to the sphere area at a temperature range of 190 to 210 F, and at a pressure of 175 psig. The chemical and utility requirements were estimated as follows:

Water:
1. 75 to 150 gpm as per sample submitted.
2. 150-200 F.
3. 175 psi.

Electricity:
1. Single phase—one 100-kva, 440-volt, 60-cycle circuit.
2. Three phase—one 10-kva, 440-volt, 60-cycle circuit.

Chemical:
1. 0.20 lb of NaOH per 1000 bbl of crude oil, if needed.

The electrosphere (with electrical and mechanical accessories) was to be supplied by Petreco under a loan agreement. Piping and installation expense was to be borne by Pan American; Petreco was to provide engineering supervision of the desalter installation.

When the proposal was accepted, the Pan American and Petreco engineering departments worked together and designed the plant in detail. The operating and technical departments were consulted and with their help the crude and water tie-ins were located, keeping the required temperatures and pressures in mind. The operating department helped arrange the equipment so that all controls, pumps, and valves were easily accessible and required a minimum amount of labor to operate and maintain.

Government priorities were granted and contracts were let for construction of the plant by independent contractors. Petreco provided engineering supervisory service during the installation of the special desalting equipment. Foundations were begun September, 1945, and the desalting plant was ready for operation March 9, 1946.

Construction of the desalting plant was accomplished without interruption of the normal operating schedule of the cracking unit; tie-ins were made during a scheduled shutdown for clean out. Thus, no lost time was chargeable against the installation.

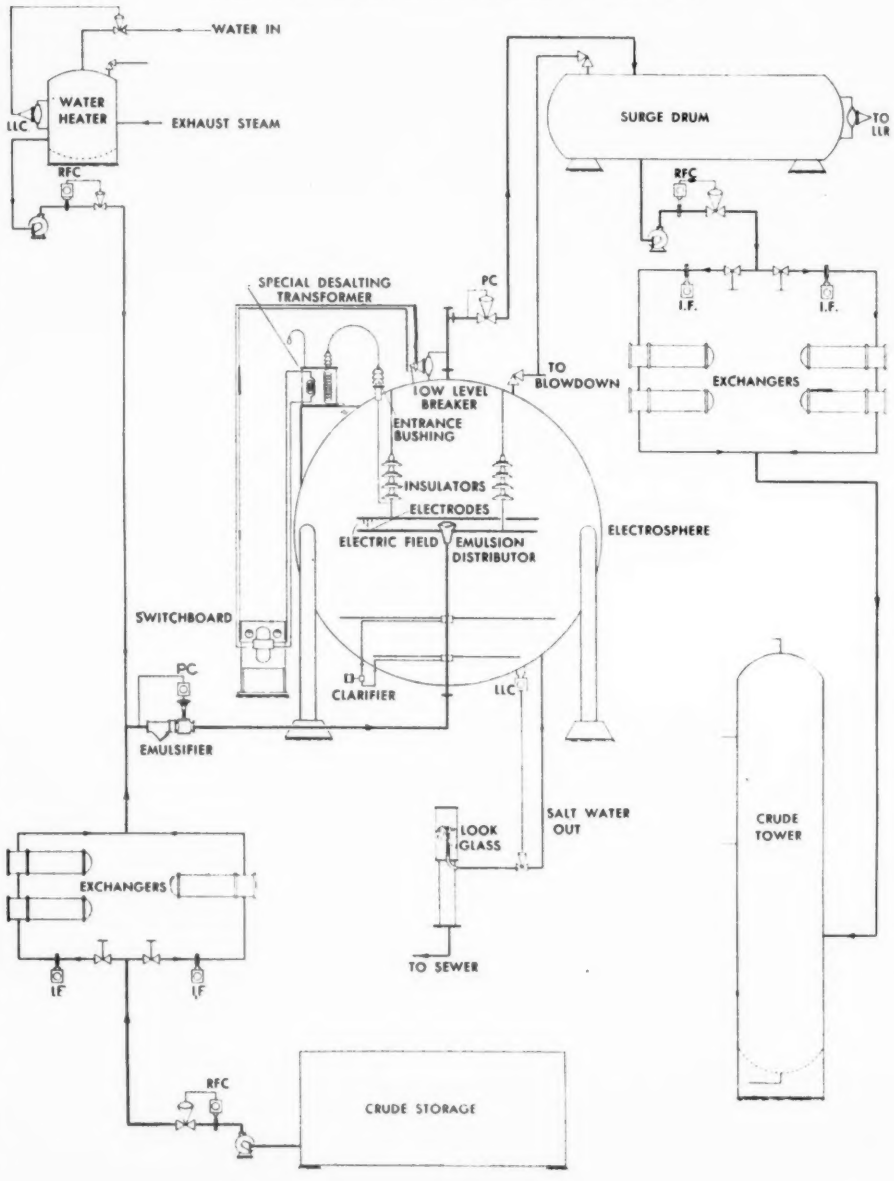
● **Operation of the desalting plant.** Fig. 1 is a diagram of the desalting plant, which operates in the following way:

Salt-bearing raw crude is pumped from storage through heat exchangers to the desalting plant. Water is heated to 125 F by contact with exhaust steam and pumped into the hot crude stream. The mixture, 95 per cent oil and 5 per cent water at 210 F, then flows through an air-operated emulsifier, which disperses the water into the crude. The emulsion then flows into the electrosphere, where it is distributed into the electric field and subjected to a voltage gradient of several thousand volts per inch.

Under the influence of the strong electric field, the added water particles and the brine particles are electrically attracted and coalesced. The coalescence takes place with remarkable rapidity and proceeds until coalesced masses are of sufficient size to settle rapidly by gravity to the bottom of the vessel.

A clarifying system operates within the water-oil separation zone to accelerate the complete separation of oil from the waste water. The water is drawn off by means of an automatic level controller and discharged through a glass-enclosed bleed fountain into the sewer.

FIG. 1. Electric desalter — crude desalting facilities, No. 2 combination unit at Texas City.



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Desalted crude is discharged from the top of the sphere into a 10-ft by 40-ft surge drum. A centrifugal pump takes suction on the surge drum and charges the desalted crude through additional exchangers into the crude flash tower.

The electrosphere consists of a spherical tank 36 ft in diam with a capacity of 4347 bbl, built according to API-ASME code specifications for 100-psi working pressure. In the vessel, the electrode system is suspended from insulators. The required high voltage is conducted into the tank by means of high-pressure electrical entrance bushings. Special desalting transformers are mounted on a platform on top of the vessel; they are supplied with 440-volt, 60-cycle electrical service. Load regulators and automatic switches control the power to the transformers. An automatic switch is mounted on top of the electrosphere to disconnect the power if the liquid level should be lowered. Duplicate relief valves provide protection against excess pressure. Electrical switchboard equipment, including meters, is mounted in explosion-proof housings, suitable for use in hazardous locations. The desalter was put in full operation on March 13, 1947. Operation was as predicted and no difficulties developed.

On March 15, the water supply was changed from well water to cooling tower water. This change was made because of a prevailing well water shortage. By using cooling tower water for added water on the desalter, a saving is made because the water is then a part of that constantly discarded to control total solids on the cooling water. As was to be expected, the use of well water for emulsification resulted in better desalting than the relatively salty cooling tower water; however, the latter gave satisfactory results. Petreco operating engineers were assigned to the unit 24 hr a day during the first 15 days in order to supervise the various changes in operation and to train the refinery operating personnel.

The unit acceptance test was made over a 24-hr period beginning at 8:00 a.m., April 2, 1946, with results as follows: Analysis of the raw-crude and desalted-crude composite test samples indicated 82.7 per cent salt removal with 2.7 gm salt per bbl of treated crude. The contract between Pan American and Petroleum Rectifying Company specifies that the desalted crude shall contain not more than 4.53 gm of salt per bbl of oil (10.0 ptb) or not exceed 10 per cent of the amount of salt in the raw crude, whichever value is the greater. As the results were well within contract requirements, the unit was considered acceptable and operations were assumed

TABLE 3. No. 2 cracking unit run summaries.

Before desalting

Run no.	Hr on stream	†Service factor	Cause of shutdown
41	930	78.8	Salt fouling of the crude preheat exchangers and visbreaker once-through furnace coils.
42	590	88.2	"
42A	425	83.4	"
42B	828	72.7	"
43	842	83.5	"
*43A	615	86.6	"
43B	152	74.5	Ruptured upper roof tube in the visbreaker once-through coils.
43C	786	79.8	Failure of elbow on crude preheat exchanger. Scheduled shutdown two days later for salt removal.
44	1157	72.1	Failure of furnace-oil stripper reflux line.
45	691	83.6	Unit shutdown March 8. Ruptured roof tube in visbreaker once-through coils caused by excessive heating due to salt deposits.
Avg.	702		

After desalting

45A	2172	89.8	Heavy coke deposits in the high pressure evaporator.
46	720	90.6	Fire in convection section of the visbreaker furnace.
46A	857	92.6	Leak in blow-down line on the visbreaker furnace.
46B	1370	82.3	Voluntary shutdown for general cleaning and repairing.
47	2705	89.0	"
Avg.	1565		

*In determining service factor this long shutdown period due to labor trouble was compensated for by allowing four days for cleaning and repairs and neglecting the remaining down-time.

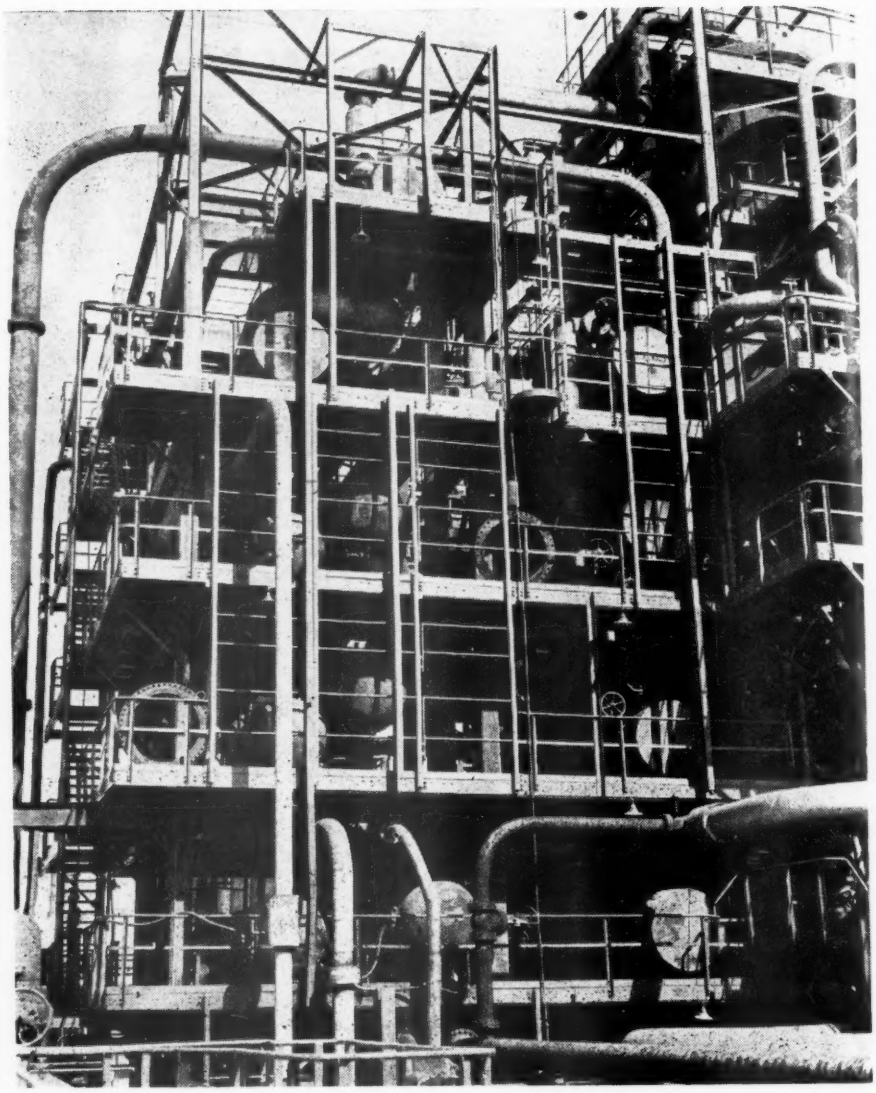
†$\frac{\text{On stream time}}{\text{On stream time + down time}} \times 100$

TABLE 4. Comparative data on No. 2 cracking unit.

	Before desalting	After desalting	Improvement (difference)
Service factor, per cent	79.9	89.3	9.4
Crude rate, bbl per stream day	38,922	46,111	7,189
Crude rate, bbl per calendar day	31,102	41,184	10,082
Average run length, hr	*702	1,565	863
Down time, days	73.3	39.0	—34.3
Cleaning exchangers, man-hours	26,813	10,638	—16,175
Cleaning furnaces, man-hours	11,239	9,680	—1,559
Repairing exchangers, man-hours	6,418	3,065	—3,353
Repairing furnaces, man-hours	3,486	1,079	—2,407
†Total for exchangers and furnaces, man-hours	47,956	24,462	—23,494
Average V. B. O. T. transfer-line, temp., F	825	860	35
Approximate average preheat temp., F	605	645	40
Average preheat duty, 10^6 Btu per hr	185	244	59

*Run No. 43B was of short duration. If this run were not considered this value would be 763 hr.

†This includes exchangers and furnaces on the unit not directly concerned with the salt problem.



View of six decks of crude preheat exchangers illustrates the difficulties involved in cleaning and repairing; however, several of these exchangers are not in crude preheat service.

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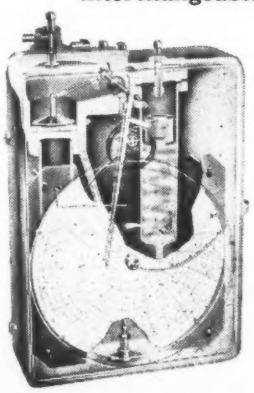

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by Pan American. Since this date operation has been entirely satisfactory.

As is customary, a Petreco field engineer was assigned to the refinery to provide operational and inspection service. This engineer cooperates with refinery personnel and advises with them with respect to operation of the desalting plant. The Petreco engineer has at his disposal the Petreco research, engineering, and development departments to solve unusual problems and to supply information regarding improvements in operation and equipment. This service relieves the refinery management and operating departments of irksome responsibilities deriving from desalting problems.

The electrical desalter in use at No. 2 cracking unit at Pan American operates with simplicity and economy along with efficient desalting. It requires very little attention for operation and does not require any additional operators to be assigned to the cracking unit. Any major changes in operation are recommended by Petreco and the Pan American operating department maintains the conditions thus specified. It is Pan American's responsibility to perform all the maintenance on the units; however, the maintenance requirements after a year's operation have been insignificant.

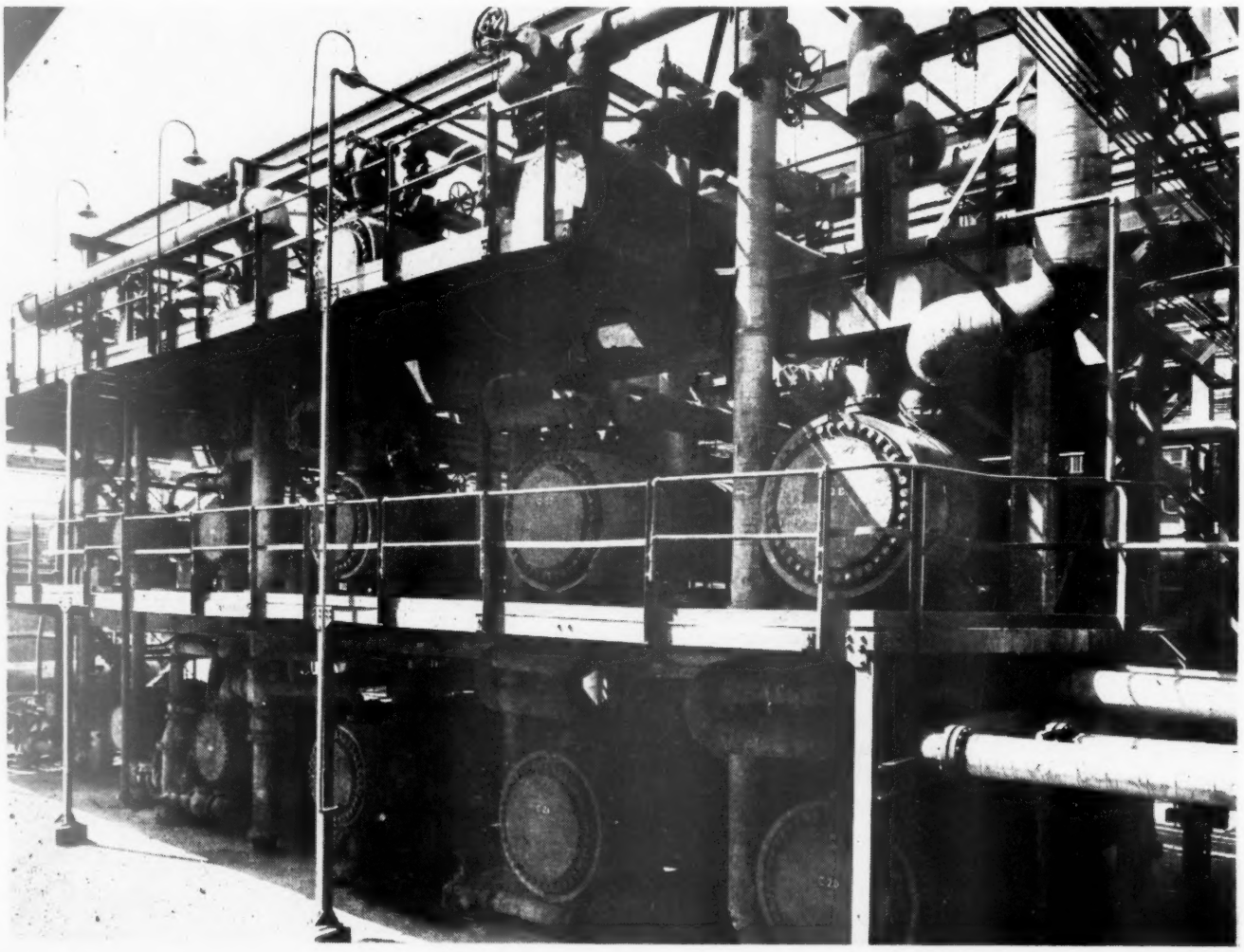
Utility costs of operating the unit are of interest. On an incremental utility-cost basis, the cost of steam, added water and electrical power amount to $8.57 per stream day, or 0.019 cent per bbl of crude charged. Assuming a liberal amount of $8000 for maintenance and repairs maintenance costs would amount to 0.053 cent per bbl of crude charged. Including a normal depreciation charge the total operating costs would then be 0.129 cent per bbl of crude plus the "service and equipment" charge by Petroleum Rectifying Company. Thus, the cost of desalting is substantially less than 1 cent per bbl and is quite small when compared to the overall savings involved.

● **Effect of desalting on No. 2 cracking unit operation.** Fig. 2 presents graphically the run lengths, crude charge rates, visbreaker once-through transfer-line temperatures, and the salt content of the raw and desalted crudes at No. 2 cracking unit for typical runs before and after desalting. These curves show quite clearly the decided improvement in operation as the result of efficient desalting. Table 3 summarizes briefly the run lengths and the reasons for the termination of runs before and after the desalter was placed in operation. Fig. 3 shows the loss in crude-preheat duty at No. 2 cracking unit for typical runs before desalting, after improved desalting in the Hastings field, and after the installation of the desalter.

Referring to Fig 2, the maintenance of crude charge rate and increased length of runs after desalting is impressive and self-explanatory. The visbreaker once-through furnace coil transfer-line temperature is indicative of the condition of these furnace tubes with relation to salt and accompanying coke formation. After desalting, these temperatures were raised from an average of 825 to 860 F without any indication of accelerated coking. Early studies of the salt problem at No. 2 cracking unit indicated that the maximum salt tolerance was 10 gm per bbl for that unit. The plot of salt content of desalted crude charged to the unit shows an average of 3 gm per bbl, which permits satisfactory operation of the cracking unit. Soon after the initial operation of the desalter in March, 1946, the improved field desalting that had been undertaken was discontinued.

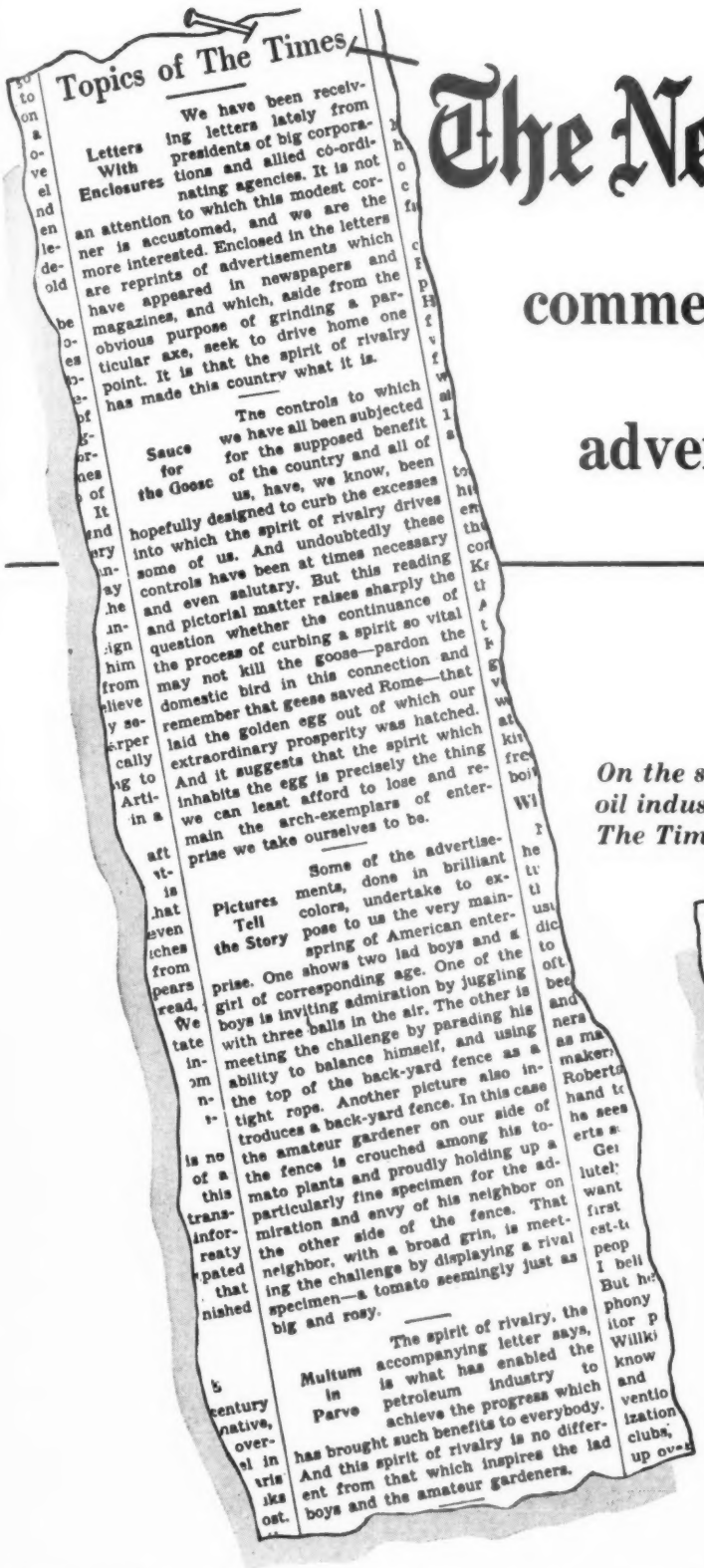
As a basis for evaluating the effect of the past year of operation at No. 2 cracking unit with the desalter in service, the year immediately preceding has been used. These two periods will be referred to in the succeeding discussion as the period before desalting and the period after desalting. Several of the shut-

Additional crude preheat exchangers. Several at far left are not in preheat service.



The New York Times

comments on Petroleum's new advertising campaign



Topics of The Times

Letters With Enclosures

We have been receiving letters lately from presidents of big corporations and allied co-ordinating agencies. It is not an attention to which this modest corner is accustomed, and we are the more interested. Enclosed in the letters are reprints of advertisements which have appeared in newspapers and magazines, and which, aside from the obvious purpose of grinding a particular axe, seek to drive home one point. It is that the spirit of rivalry has made this country what it is.

Sauce for the Goose

The controls to which we have all been subjected for the supposed benefit of the country and all of us, have, we know, been hopefully designed to curb the excesses into which the spirit of rivalry drives some of us. And undoubtedly these controls have been at times necessary and even salutary. But this reading and pictorial matter raises sharply the question whether the continuance of the process of curbing a spirit so vital may not kill the goose—pardon the domestic bird in this connection and remember that geese saved Rome—that laid the golden egg out of which our extraordinary prosperity was hatched. And it suggests that the spirit which inhabits the egg is precisely the thing we can least afford to lose and remain the arch-exemplars of enterprise we take ourselves to be.

Pictures Tell the Story

Some of the advertisements, done in brilliant colors, undertake to expose to us the very mainspring of American enterprise. One shows two lad boys and a girl of corresponding age. One of the boys is inviting admiration by juggling with three balls in the air. The other is meeting the challenge by parading his ability to balance himself, and using the top of the back-yard fence as a tight rope. Another picture also introduces a back-yard fence. In this case the amateur gardener on our side of the fence is crouched among his tomato plants and proudly holding up a particularly fine specimen for the admiration and envy of his neighbor on the other side of the fence. That neighbor, with a broad grin, is meeting the challenge by displaying a rival specimen—a tomato seemingly just as big and rosy.

Multum in Parvo

The spirit of rivalry, the accompanying letter says, is what has enabled the petroleum industry to achieve the progress which has brought such benefits to everybody. And this spirit of rivalry is no different from that which inspires the lad boys and the amateur gardeners.

On the subject of the oil industry's advertising, The Times continues . . .

Mark Twain Is Responsible

No mention is made by the petroleum spokesman of the use to which Tom Sawyer put the spirit of rivalry when it came to a whitewashing job. That, we submit, is a classic example of American enterprise, and one which, in the past, has not lacked admiration—or imitation in circles less juvenile. In such cases it has been roundly denounced as exploitation.

In Tom Sawyer, too, the American spirit spoke—and spoke in native accents. But the accent today is no longer on exploitation. Rivalry has become not a race for private profit but the firm foundation upon which rests the entire fabric of our national economy. It must be preserved.

Reprinted courtesy of *The New York Times*

Put this campaign to work for YOU

● Petroleum's informative and dramatic national campaign in LIFE, LOOK, COLLIER'S and SATURDAY EVENING POST can go to work directly for *you*. Each ad can tell your local audience important facts about your branch of the business. All you have to do is personalize these ads over your own company's signature. A FREE Plan Book has been prepared to make this tie-in practical and easy for you.

Just Mail the Coupon

. . . to get a complete promotion portfolio. This detailed Plan Book offers FREE mats of seven complete and different newspaper campaigns, plus display material, radio scripts, envelopes, enclosures – the complete promotion picture for *your* firm.

DON'T DELAY—ACT NOW

Send for your free Plan Book at once. Available to managers and officers of all oil companies, oil associations and affiliated organizations.

Mail this coupon today.

Public Relations Operating Committee, Dept. 21F
AMERICAN PETROLEUM INSTITUTE
670 Fifth Avenue, New York 19, N. Y.

Please forward at once FREE copy of Plan Book.

Name .....
Title .....
Company .....
Address .....
City ..... *State* .....

downs before desalting were not directly attributed to salt; however, this should not detract from a logical comparison, for none of the shutdowns after desalting could be attributed to salt deposition.

Table 4 presents pertinent data on evaluating the operation at No. 2 cracking unit before and after desalting. It should be noted that the tabulated manhours consumed in cleaning and repairing exchangers and furnaces include other exchangers and furnaces not directly concerned with the salt problem. The salt problem has direct bearing only on the visbreaker once-through furnace coils and the crude preheat exchangers. During the "before desalting" period, certain labor disturbances also may have exaggerated differences in these items.

No attempt has been made to determine the decrease in equipment replacements, such as tube bundles and furnace tubes destroyed by excessive overheating and cleaning. The decrease may be appreciable over a long period of time; however, to date it has not been of very great consequence. Likewise, the corrosion problem has been relieved by desalting, but this is a negligible factor among the overall advantages. Despite the increased throughput, it was observed during the past year that corrosion has been reduced on three exchangers that are used to reheat visbreaker tower overhead. Also, a reduction in corrosion was noted in the cooler on the after-fractionator. (The after-fractionator cuts the pressure distillate to 400 F end point.)

An appreciable advantage of efficient desalting has been the ability to increase the severity of cracking without causing salt and coke formation in the visbreaker furnace coils. The once-through transfer-line temperatures have been increased 35 F to 860 F, and the recycle-coil transfer-line temperatures 5 F to 930 F. Besides the advantage of producing more gas oil and gasoline, additional preheat is thus available to the crude system. This in turn effects more efficient crude flash tower operation, notably in the quantity and quality of virgin gas oil produced.

● **Conclusions.** The installation of the electrical desalter at No. 2 cracking unit has proved itself a very profitable investment. None of the runs terminated during the past year as a result of salt fouling. The total cost of desalting is substantially less than 1 cent per bbl of crude. Inasmuch as the desalter is the property of Petroleum Rectifying Company and the operational service is provided by them, the royalty or "service and equipment" charge is the principal item of expense.

The desalter has made it possible for No. 2 cracking unit to perform efficiently at constant maximum throughput and cracking conditions. The desalter has proved to be versatile in that it can desalt efficiently either the naphthenic or paraffinic crudes, which are charged to the unit with a minimum of operational changes. It has consistently desalted raw crude (15 to 30 gm per bbl) to approximately 3 gm per bbl. An additional advantage that has proved to be efficient in pilot-plant tests by Petroleum Rectifying Company is the processing of tank bottoms by the desalter at the rate of 5 per cent of the total charge; however, this process has not been undertaken at Pan American. Other advantages that have resulted are: Better scheduling of shutdown orders, more efficient use of labor, improved fractionation, and removal of the necessity for additional desalting in the Hastings field.

Difficulties have been encountered with salt-bearing crudes at No. 1 cracking unit and economic study of desalting has been made. This indicated a payout time of less than a year with a desalter under the present price structure. An added point of interest is the lower incremental royalty rate that would be effective using the same Petreco system. A contract has been let, and another desalting unit will be installed in the near future at No. 1 cracking unit similar to the one at No. 2 cracking unit.

● **Acknowledgment.** The writers wish to acknowledge the cooperation and information supplied by the Petroleum Rectifying Company in the preparation of this paper. ★★★

FIG. 2. No. 2 cracking unit—typical runs before and after desalting.

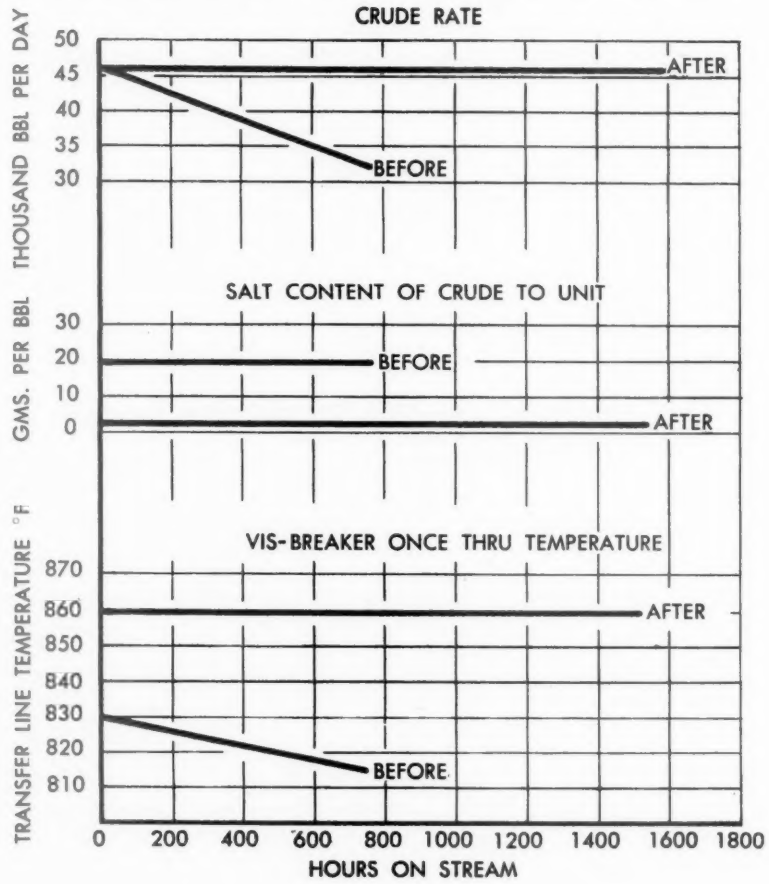
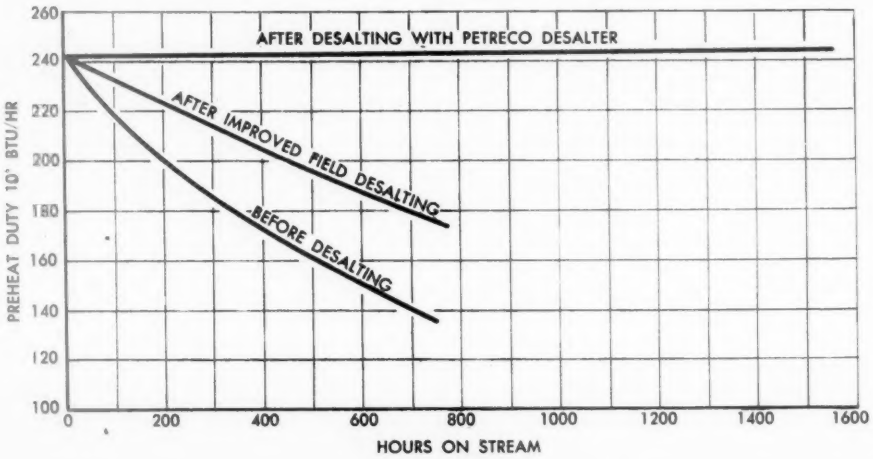


FIG. 3. Preheater performance—typical runs at No. 2 cracking unit.



Crossing of Mississippi at New Orleans

By O. C. IRVINE, United Gas Pipe Line Company

EXCLUSIVE

UNITED Gas Pipe Line Company installed in August the first natural gas pipe line crossing of the Mississippi River below New Orleans. Through other pipe line facilities completed October 1 it is now possible to deliver gas produced in four additional South Louisiana fields to the growing number of industrial, commercial, and domestic consumers in and adjacent to the Cresent City.

Representing a major undertaking in the overall project of connecting Barataria and other fields with New Orleans by pipe line, the new river crossing was designed for multiple, submarine construction. The 10-in. lines with ½-in. wall thickness provide the maximum assurance of continuous delivery in the event of underwater damage. From header to header, the individual river lines are 3300 ft long; and welded, coated, and weighted with 1500-lb river clamps, they weigh approximately 537 tons.

The crossing enters the Mississippi at Cutoff, emerging on the opposite bank just southwest of Parkenham Oaks, on State Highway No. 1, in Chalmette. A work barge, derrick barge, storage barge, and other marine-type facilities were employed to accomplish the crossing in a minimum of elapsed time. Previously welded into 80-ft lengths, Somastic coated, and fitted with river clamps, the sections of pipe were towed to the barges for welding into continuous lines and lowering to the river bottom.

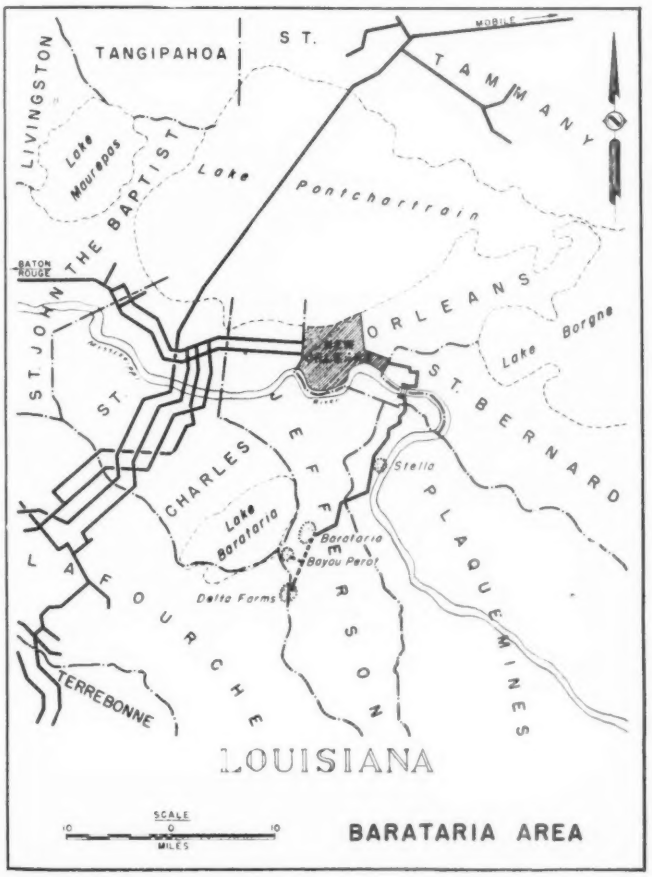
Although United's new crossing of the Mississippi is the first to cross below the city, it is the third in the New Orleans area. The first was at Nine Mile Point, in 1928, and the second at St. Rose, in 1940. Additional crossing lines were also laid at St. Rose in 1941, 1942, and 1943.

The third 10-in line of the triple-line crossing was laid August 13, well in advance of completion of other portions of the Barataria-New Orleans pipe line. The Barataria-New Orleans line, including both field pipe line facilities and a main transmission artery, in view of anticipated increased requirements, was in the planning stage several months before construction began. In line with United's general policy of providing more gas to match industrial growth, it assures Greater New Orleans nearly one-third more natural gas delivery capacity than ever before.

The Barataria-New Orleans line, aside from the Mississippi River crossing at Chalmette, consists of approximately 17 miles of 12-in line, five miles of 16-in, and 0.35 mile of 20-in, providing a maximum capacity of 63,000,000 cu ft a day, or a 30 per cent increase over the capacity of previously existing facilities in the New Orleans district.

Also included in the project installed to provide for New Orleans Public Service Company's and Louisiana Power and Light Company's increased natural gas requirements in Jefferson, Plaquemines, Orleans, and St. Bernard parishes through connecting Barataria, Delta Farms, Bayou Perot, and Stella fields

Map shows route of new pipe line and point of entry into New Orleans metropolitan area with reference to existing lines.



Construction scene, north of Mississippi River, showing section of line to provide additional gas for Greater New Orleans.

to the New Orleans area, are one dual 12-in. and two dual 6-in. sales measuring and regulating stations, one dual 8-in. purchase measuring station, two single 4-in. purchase measuring stations, two 60-in. scrubber installations, and one 12-in. check measuring station.

Last minute completions of the Barataria-New Orleans pipe line project included some 700 ft of the four-mile section of 16-in. line on the north side of the river, tie-in to the north header on the Mississippi River crossing, the Mehle Street City Gate Station building and tie-in work at the Louisiana Power and Light meter station on Paris Avenue.

Previously completed were: The line from Barataria field to the south bank of the Mississippi River, approximately 18 miles; the river crossing lines, including complete tie-in to the south header, and the 20-in. line extending from United's 16-in. line on Mehle Street to the tie-in with the New Orleans Public Service Company's line at the St. Bernard Parish line. Cleaning plugs were run through the 12-in. section, and shut in pressure tests were satisfactorily completed.

Gas received from Bayou Perot and Delta Farms fields through the lines of another operator, together with gas produced in the Bartaria field will be transported from Bayou Barataria by the new 12-in. line, which will also pick up the gas from deep sands in the Stella field, and delivery will be made to Louisiana Power and Light Company and New Orleans Public Service, Inc., on the east side of New Orleans. Thus, the city will be provided city gate stations on opposite sides of the metropolitan area, minimizing the problems of proper maintenance of pressures and volumes.

Although the Barataria field has a deep gas sand from which supplies can be drawn, the new line is also designed to take care of the flare gas that comes from the oil sands and has heretofore been burned in vents in the field for lack of a market. It will also provide an outlet for gas from the gas-condensate sands at Stella field, which for a similar reason have been closed-in since their discovery.

Other United Gas lines, serving Greater New Orleans with a maximum capacity of approximately 209,000,000 cu ft a day, transport gas from 15 scattered Louisiana fields. The new line,

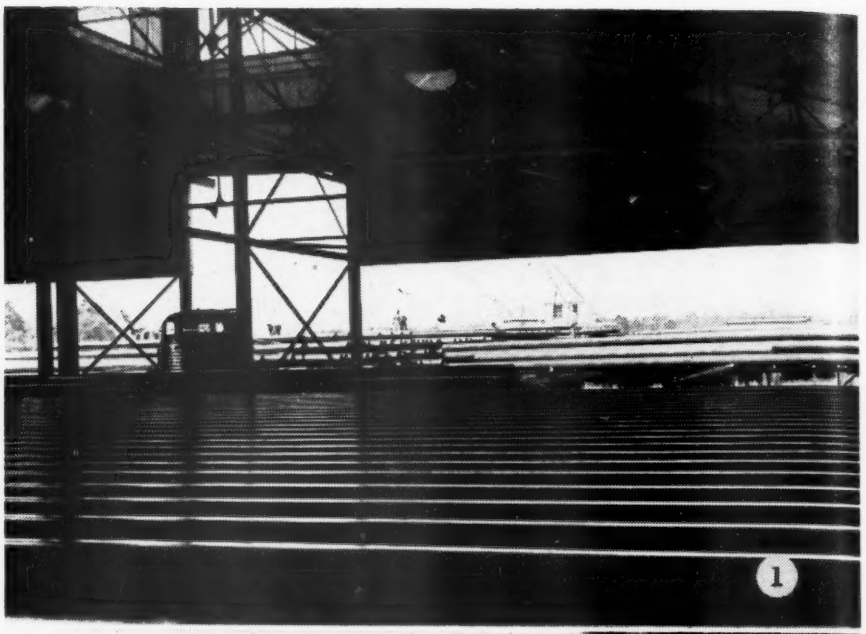


FIG. 1. 12-in. pipe for the Barataria-New Orleans project, "primed" and ready to be "doped," in a building of the Pipe Line Service Corporation at its Harvey, Louisiana, plant.

FIG. 2. Pipe line construction crew lining up and "tack" welding 12-in. pipe along the bank of The California Company canal.

FIG. 3. George Ward, chief inspector on the project, looks back as three other members of his party follow the pipe line in a marsh near Crown Point.

SAVE TIME ON HOOKUPS. Dressers quickly hook up pipe zigzags like this, where a 6″ lateral enters a 10″ main. Helpful on any valve connections and tank hookups.

"10,000 without a single leak"

. . . says Texas oil line manager

If you want protection against leaks, use Dressers.

Tightness has been a characteristic of these couplings for more than 50 years. Their time-proved design and specially compounded rubber gaskets enable any workman to make a permanently tight joint *every time.* The only tool needed is a wrench.

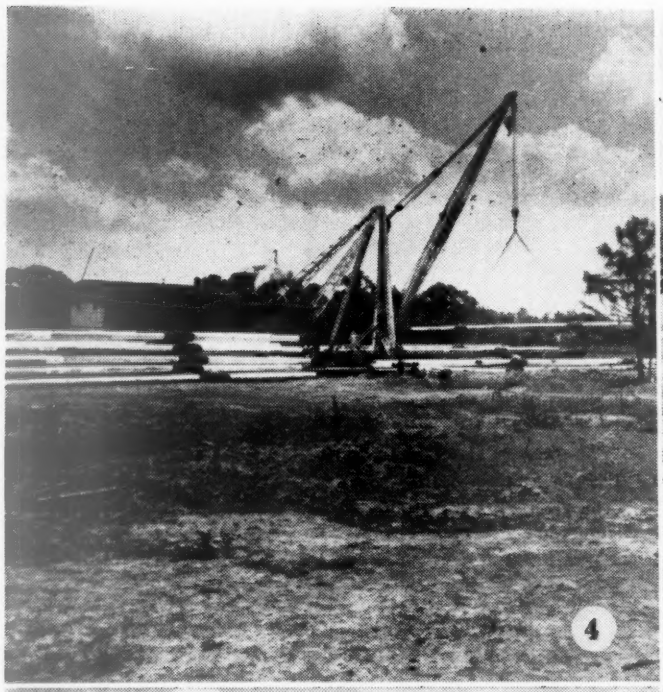
Dressers protect you against delays, too. The crew shown here laid 5.2 miles in 11 hours. Write now for full information on these time and money-saving pipe joints. Order from our Houston warehouse or your oilfield supply store.

★ ★ ★

DRESSER MANUFACTURING DIVISION, BRADFORD, PA.
Houston Office and Warehouse, 1121 Rothwell St., Sec. 16, Houston, Texas. In Canada, Dresser Manufacturing Co., Ltd., 60 Front St., West, Toronto, Ontario.

DRESSER COUPLINGS

ONE OF THE DRESSER INDUSTRIES



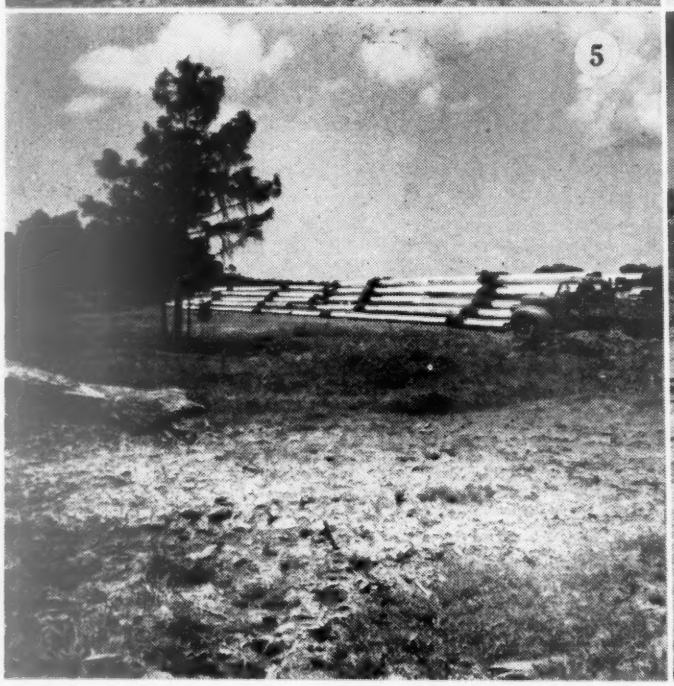


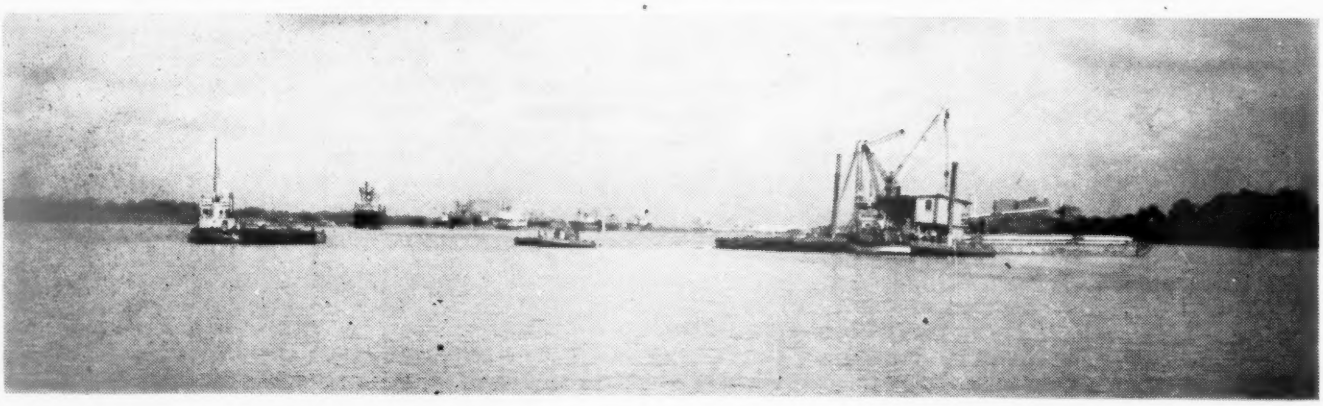
FIG. 4. Derrick barge loading 10¾-in. coated and weighted pipe for multiple submarine crossing of the Mississippi River.

FIG. 5. Welded into 80-ft sections, this pipe has been Somastic coated and has 1500-lb river weights bolted on.

FIG. 6. This 16-in. header for the Mississippi River crossing was hand doped and wrapped. "Jeep" is used to test coating.

FIG. 7. Drilling crossing of St. Claude Avenue on 20-in. section between Mehle Street station and Orleans parish line.

Below, general view of Mississippi River crossing operation as three under-water lines were laid in August.



Soaker Gets a New Stainless Liner

By R. H. Davies, Consulting Engineer
Cleveland, Ohio

One of the recurring jobs at a gasoline refinery is the replacement of the stainless steel linings in the soakers. Fig. 1 shows three soakers at the refinery of a leading oil company. They are 60 feet high, 7 feet in diameter and have a 6-inch wall. Oil at 1000 lbs. pressure and a temperature of 1000° F. goes from the furnaces to these soakers, where the coke is "soaked out" before the oil passes to the separator.

Coke accumulates in the soakers so fast that only two of them are in operation at once, one always being shut down for cleaning. The combination of high pressure and temperature and frequent cleaning causes the stainless steel linings to corrode and wear down, so that a lining has to be replaced about every two years.

Fig. 2 shows the top of a soaker, with man-hole swung aside so welders can get inside to install the new lining. The man covered with a raincoat is controlling the elevator platform installed inside the soaker to move the welders up and down.

Fig. 3 shows the welding of a new lining of 18-8 stainless steel on the inside of a soaker. The lining is especially made for this purpose in 16 gauge sheets, 8″ x 18″, each sheet stamped with 10 holes for plug welding to the mild steel wall. On this type of work Lincoln "Stainweld D" electrode is used.

The welder forms a sheet to the wall's contour by holding it against the wall and tapping lightly with a hammer. Then he lines it up with 1/16″ gap from adjacent sheets and tack welds it in position with six tacks. Next he makes the plug welds. After a group of sheets have been tack welded and plug welded, he makes the one-pass vertical and horizontal welds which join the sheets. The vertical welds are made by the usual welding down procedure. Fig. 4 is a close-up of a horizontal weld being made.

Fig. 3. Welding the stainless steel lining to inside wall of soaker.

Fig. 1. These three soakers, erected in 1928, have the old style 6″ wall.

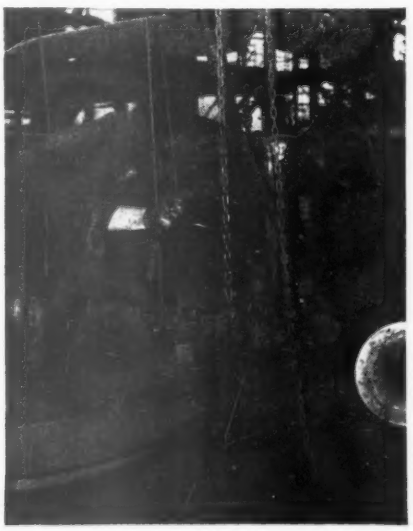
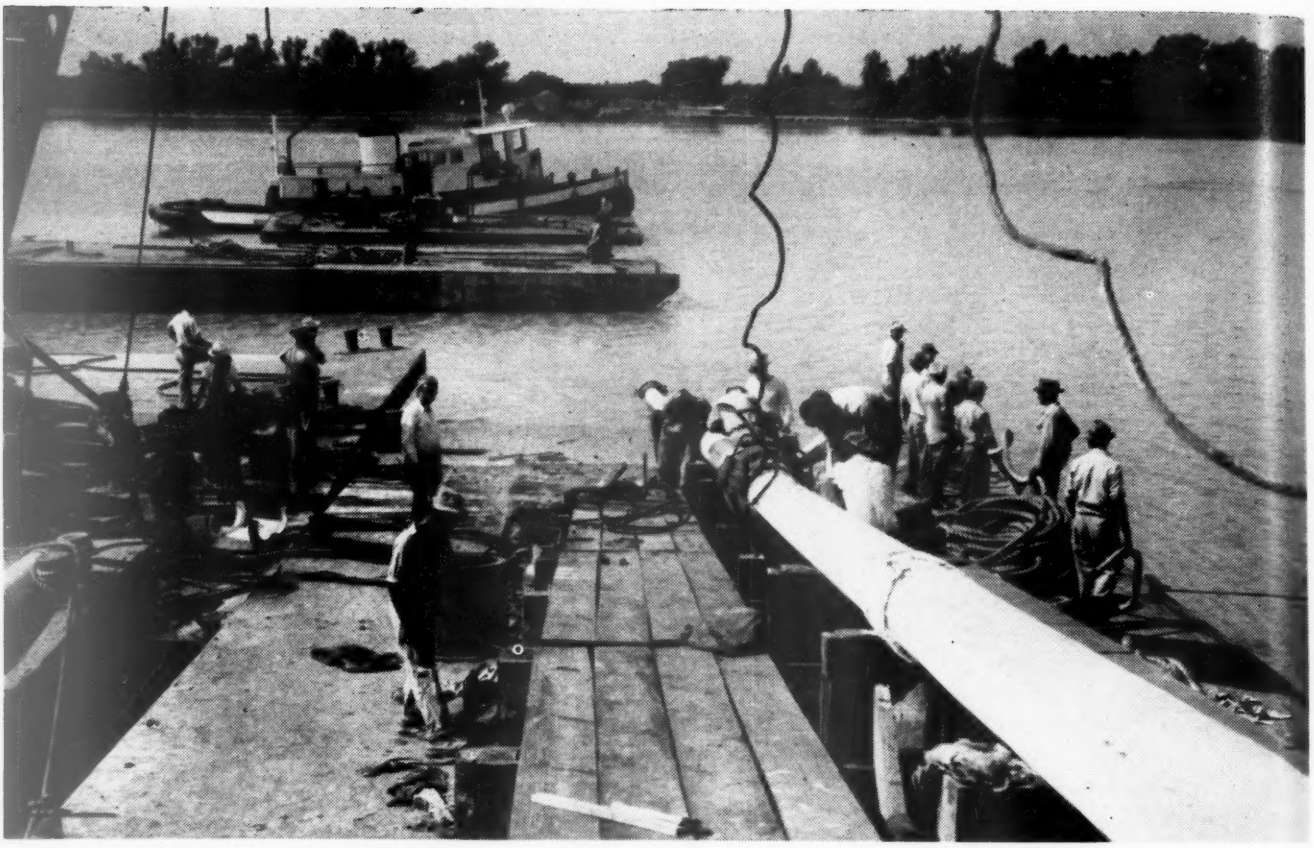


Fig. 2. Man at top of soaker operates the gasoline engine driven platform inside.

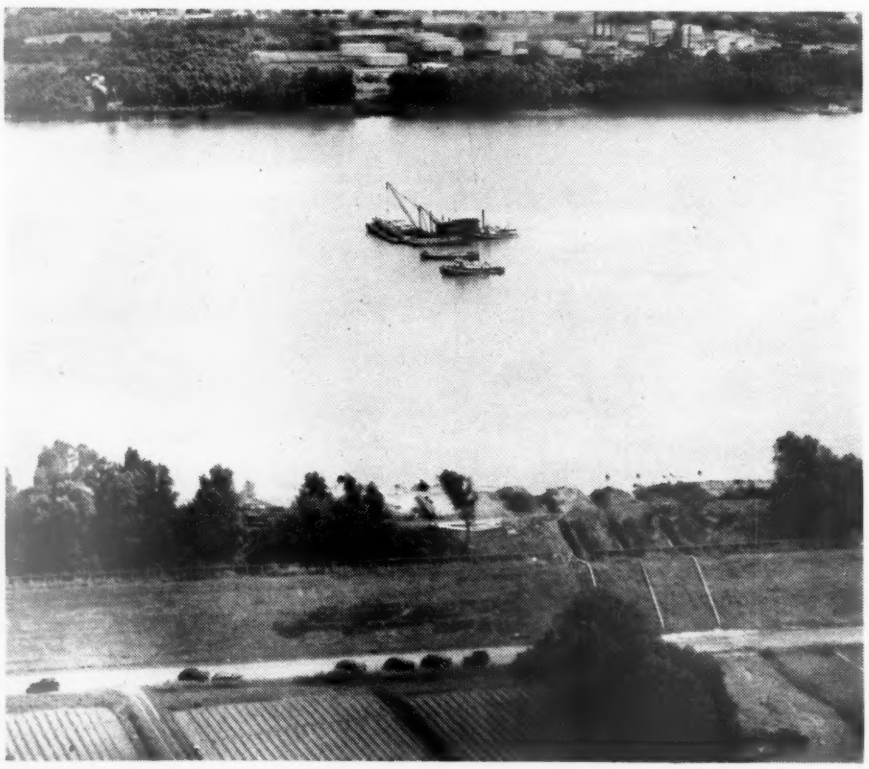
Fig. 4. Making a horizontal weld at the top of a section of sheets.

The above is published by LINCOLN ELECTRIC in the interests of progress. Procedures and properties for "Stainweld" electrodes are given in 56-page Weldirectory. For a free copy, write The Lincoln Electric Company, Dept. 426, Cleveland 1, Ohio.



Close-up view of Mississippi River crossing installation as one of three 10-in. submarine lines was in process of being laid. Previously welded into 80-ft sections, Somastic coated, and weighted with 1500-lb river weights, barges were used to weld the pipe in mid-stream and to lower it to the river bottom.

In the Barataria-New Orleans pipe line projects the installation of last of three 10-in. tubes, Mississippi River crossing, Chalmette, was made August 13, 1947.

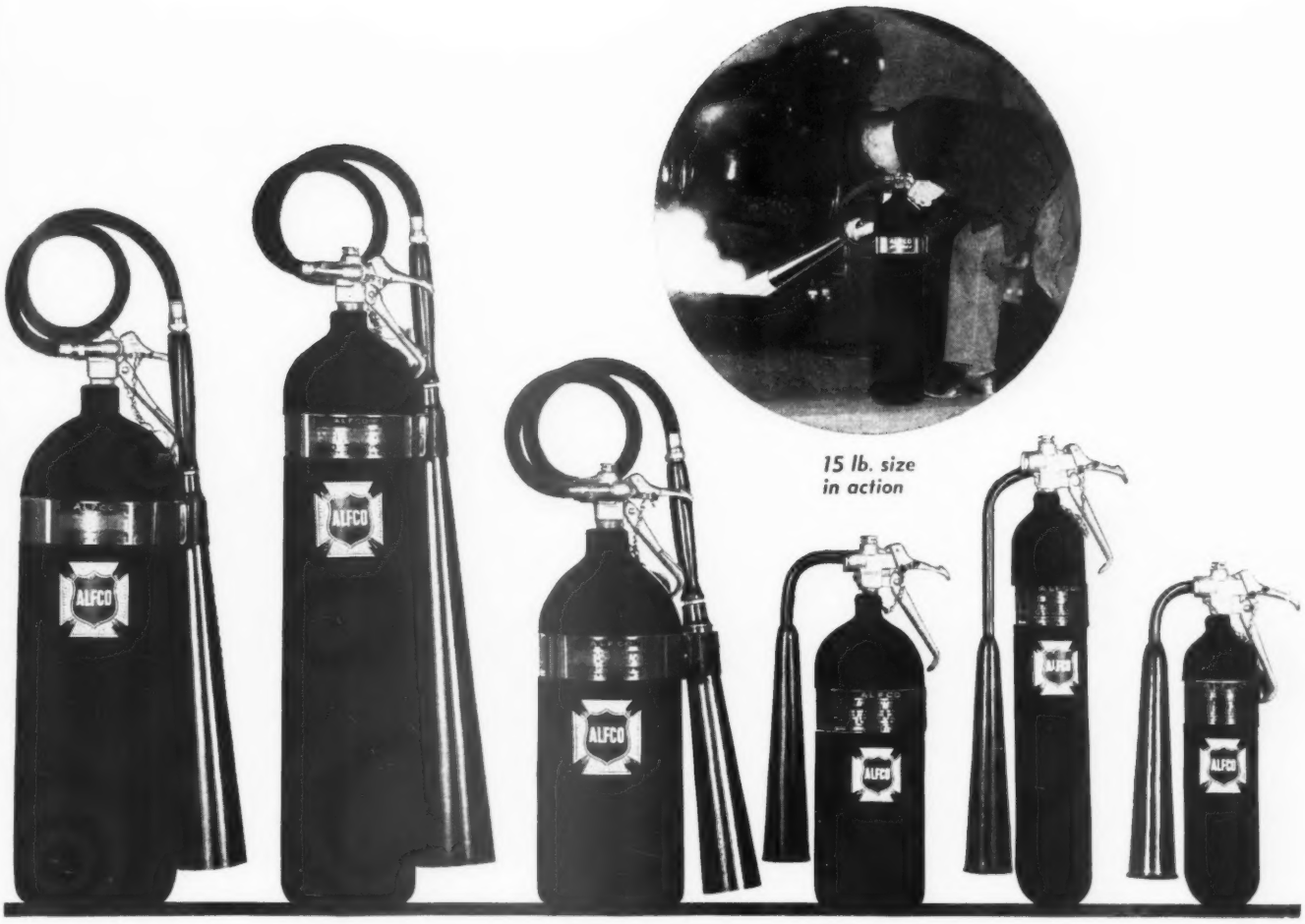


with its connections in four fields, brings to 19 the total number of fields surrounding New Orleans from which pipe lines will now draw the area's supply and raises the maximum day's capacity to about 272,000,000 cu ft. This project was planned in anticipation of major industrial expansion and is believed to be adequate to meet all the gas needs of the area for some time to come.

The history of the gas business in New Orleans is as colorful as the background of the city itself. Almost 130 years ago, James H. Caldwell went to New Orleans with a troupe of English actors. In 1822-23 he built the American Theater on Camp Street, the first building in the city to be lighted with gas. He had sent to England for a "gas machine" with which to light his new theater. Some time later he also built the first St. Charles Theater, which featured a chandelier containing 23,300 cut-glass drops and 250 gas lights.

Gas historians name New Orleans as the fourth city in this country to erect a gas plant. Gas was first manufactured in London in 1812, and was produced in Baltimore in 1816. By 1830, New York and Boston had their streets lighted with gas. The Louisiana legislature passed an act in 1829 incorporating the "New Orleans Gas Light Company," but this company failed to act and in 1833 the franchise was given to Caldwell. In 1834-35, he built the first gas plant, which was operated by slave labor for many years.

In 1849, Caldwell proposed a change from oil lamps to gas lamps for street lighting, and tradition indicates that he obtained such a contract and installed a gas light system in the city's streets. The New Orleans Gas Light Company had its



15 lb. size in action

20 lb. 15 lb. 10 lb. 5 lb. 3⅝ lb. 2½ lb.

ALFCO SPEEDEX FIRE EXTINGUISHERS

Spout Quick Death to Fire!

They put out fires in a hurry! If required, the entire contents expanding to 450 times stored volume, can be discharged within 25 seconds. You'll like these handy, quick-acting Alfco Extinguishers, their ease of operation, their fast discharge of a lot or a little of carbon dioxide gas as needed.

You'll like having nothing to clean up. The gas dissipates without a trace — and you'll like the convenience of size, the good looks too. They're really smart in appearance.

There is a capacity size model to meet your requirements from 20 lbs. down to 2½ lbs.

Wheeled Engines also available in 50, 75, and 100 lb. sizes.

AMERICAN-LAFRANCE-FOAMITE *Corporation*

ELMIRA · NEW YORK · U.S.A.

FIG. 8. Mississippi River crossing operation, showing "lowering in," derrick and work barges. Note anchored steamship in background.

FIG. 9. Early morning scene of derrick barge moving 80-ft. section of pipe from storage barge to work barge for welding.

FIG. 10. Close-up of derrick barge in action at the crossing.

ups and downs, but its business grew with the city until about 1872. Business declined after that date until 1901, when the "New Orleans Lighting Company, Lessee," injected new life into the system. New Orleans Public Service, Inc., was organized in 1922 and has served the city ever since.

After the discovery of natural gas in the Monroe field the Interstate Natural Gas Company began construction of a pipe line from Monroe to Baton Rouge in March, 1926. H. F. Carr, now district manager of United Gas Pipe Line Company's New Orleans district, was employed first as purchasing agent and later as field engineer for the construction organization that built the line for Interstate.

In 1927, the Southern Gas and Fuel Company was organized and began construction of a line from Baton Rouge to New Orleans. An 18-in. line was laid 72 miles to Destrahan that year, delivering its first industrial gas on August 6 to Godchaux Sugars, at Reserve, Louisiana. The following year, the remaining 14 miles of line was laid into a city gate station in Metairie, just a few blocks from the present city gate station on Air Line Highway at the 17th Street Canal. Natural gas was turned into the Market Street Power Station, source of the city's electricity, on October 8, 1928.

Southern Gas and Fuel Company, succeeded by United Gas Public Service Company, operated the line for nine years, looping and reinforcing it as demand for natural gas increased year after year. United Gas Pipe Line Company, succeeding these predecessor companies in 1937, continued the program of bolstering the city's gas supply.

Since 1940, when United completed construction of 48 miles of 12-in. line from the Lirette field, in Terrebonne Parish, to St. Rose, where it was tied into the line from Baton Rouge, many pipe line projects have been completed and many new sources of supply have been connected to keep apace of the growing demand for natural gas in the New Orleans area.

With the completion of the Barataria field-New Orleans line United Gas Pipe Line Company has opened up another major source of natural gas for this continuously growing market. United Gas supplies all gas sold by New Orleans Public Service, in the city, and by Louisiana Power and Light Company, around New Orleans. Both companies will receive gas at new city gate delivery stations at the eastern edge of New Orleans.

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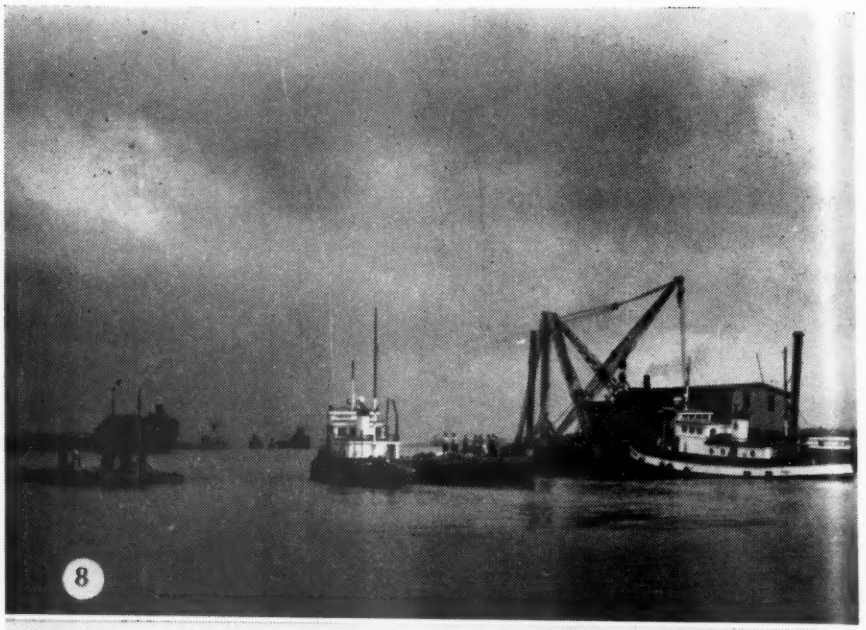

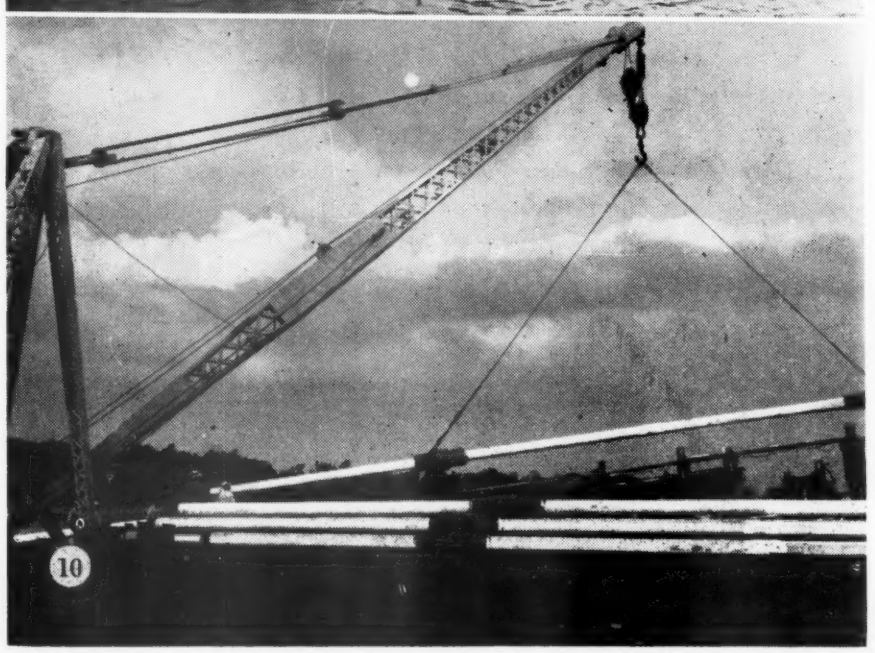

SUBJECT: Crating for export

From a drilling superintendent in Venezuela . . . .

"Our equipment has come in perfect, the crating could not be better . . ."

Dear Mr. Lee:

I thought you would be interested in the following quotations from a letter from Pariaguan, Venezuela, from our drilling superintendent.

"Our equipment has come in perfect, the crating could not be better and the agent, with a little pushing, gets the job done and quick.

"I spent ten days at Guanta and of all the material received there, ours was the best. You cannot imagine the mess things are in at the custom house. First class material was going to waste for lack of proper crating and handling, many crates broken open with valuable material damaged. After seeing the other crates, I think that Lee's crating, at any price, was cheap."

Very t...

THIS letter tells better than we could, one reason why leading companies use our crating service. They have found that it helps them get their shipments to their customers in perfect condition.

That is important, of course, but it is only one of many reasons why Lee's Expert Export Crating is so popular. Look at the list of benefits at the right. Phone, write or wire us and let us explain how each advantage of our service works in your case.

Check up with the principals we serve. We are sure you too will join the large and ever-growing list of leading companies that regularly use

LEE'S EXPERT EXPORT CRATING

LEE'S EXPERT EXPORT CRATING

What it is

A complete export crating service that includes:

***Dismantling of equipment* if desirable.**

***Sorting parts* for efficient crating and reduction of duties.**

***Weighing, counting and listing.*—Double checking prevents errors and minimizes fines by customs officials.**

***Scientific packing* to prevent rust and damage.**

***Anything else* related to export:—finding scarce equipment, expediting shipments, etc.**

What it costs

Many companies have found, by comparing cost records, that we can do their crating cheaper than they can do it themselves. They also discovered, when they used our service, that many unexpected savings show up. Insurance rates are often reduced, fines are minimized, and damage in shipping is eliminated.

LEE CONSTRUCTION COMPANY
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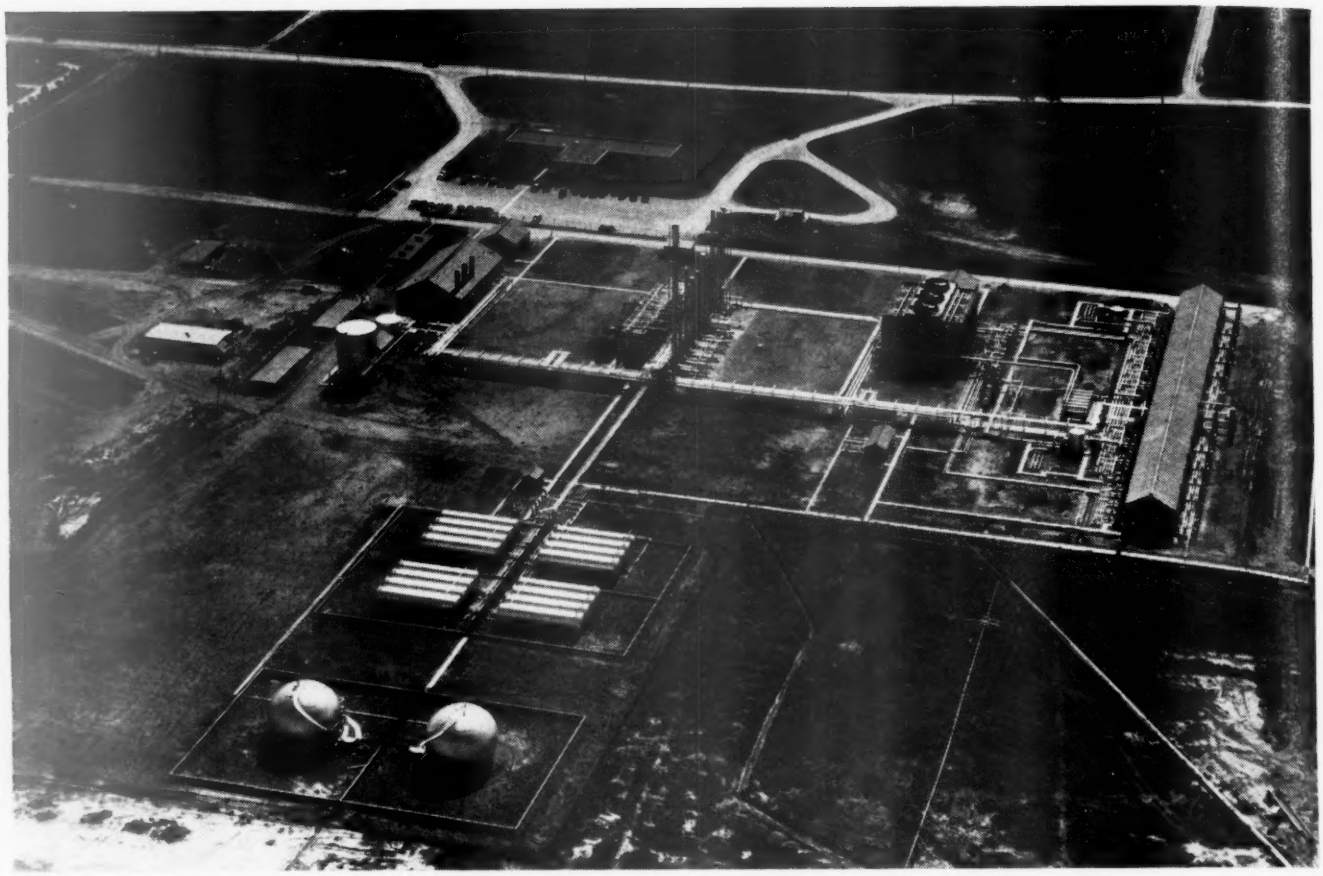

Aerial view of complete plant. Storage in foreground, distillation structure at center, boiler house at left, cooling tower and compressor building at right, office and truck loading rack at top.

Hastings field gasoline plant

By HAROLD F. DAWE* and HENRY N. WADE†

EXCLUSIVE

THE Stanolind Oil and Gas Company has recently completed the Hastings field, Texas, gasoline plant in the company's broad program to conserve natural gas resources. The plant is south of Houston midway between Pearland and Alvin, Texas, on Texas State Highway No. 35 near the Stanolind camp.

The installation is designed to handle 30,000,000 to 40,000,000 cu ft a day and now returns approximately 22,000,000 cu ft a day to a gas storage formation while processing an intake volume of 36,000,000 cu ft.

The gas production in the Hastings field comes from approximately 5000 acres and from 670 wells. The wells produce to a number of tank batteries. These batteries have been merged into a vast network of gathering lines 2 in. to 16 in. in diam and more than 35 miles in extent.

Due to the use of gas lifts and other field demands, a variable quantity of residue gas is taken from the plant at pressures from 700 to 1600 psi. This quantity varies from 6,000,000 to 9,000,000 cu ft a day. It is dehydrated before leaving the plant to prevent any possible freeze-offs at field pressure reductions.

● **Inlet pressures.** The inlet gas pressure to the plant varies from 9.8 to 24 psia. The gas is metered as it enters the plant and passes through inlet drip tanks. These are underground and are ahead of the inlet scrubbers. The scrubbers are very large and are specially designed to trap any excess of liquid moving into the plant through the suction lines.

● **Cycled gas.** Gas entering the gas cycle from the inlet gas scrubbers is compressed to absorber pressure of 715 psia through three stages of compression in a battery of nine 1000-hp compressors. The gas from each stage is cooled in atmospheric cooling coil sections in the cooling tower and the condensate removed in interstage separators. The final discharge gas from the third stage, after cooling, goes to two absorbers where it is contacted with absorption oil.

The unabsorbed or residue gas from the absorbers is taken as suction gas to the first stage of three 800-hp compressors. This gas is compressed through two stages to the field injection pressure. Between the first and second stages of residue gas compression the gas is intercooled and lubricating oil condensate is separated. The residue gas supplied to the field for gas lift can be removed between the first and second stages of resi-

*Gas engineer, The Stearns-Roger Manufacturing Company, engineers, contractors and manufacturers, Denver, Colorado.

†Consulting engineer, The Stearns-Roger Manufacturing Company.

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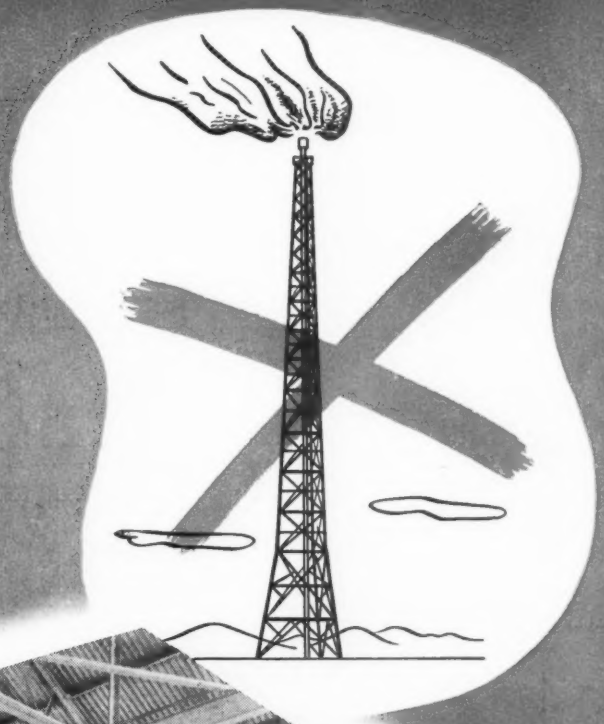

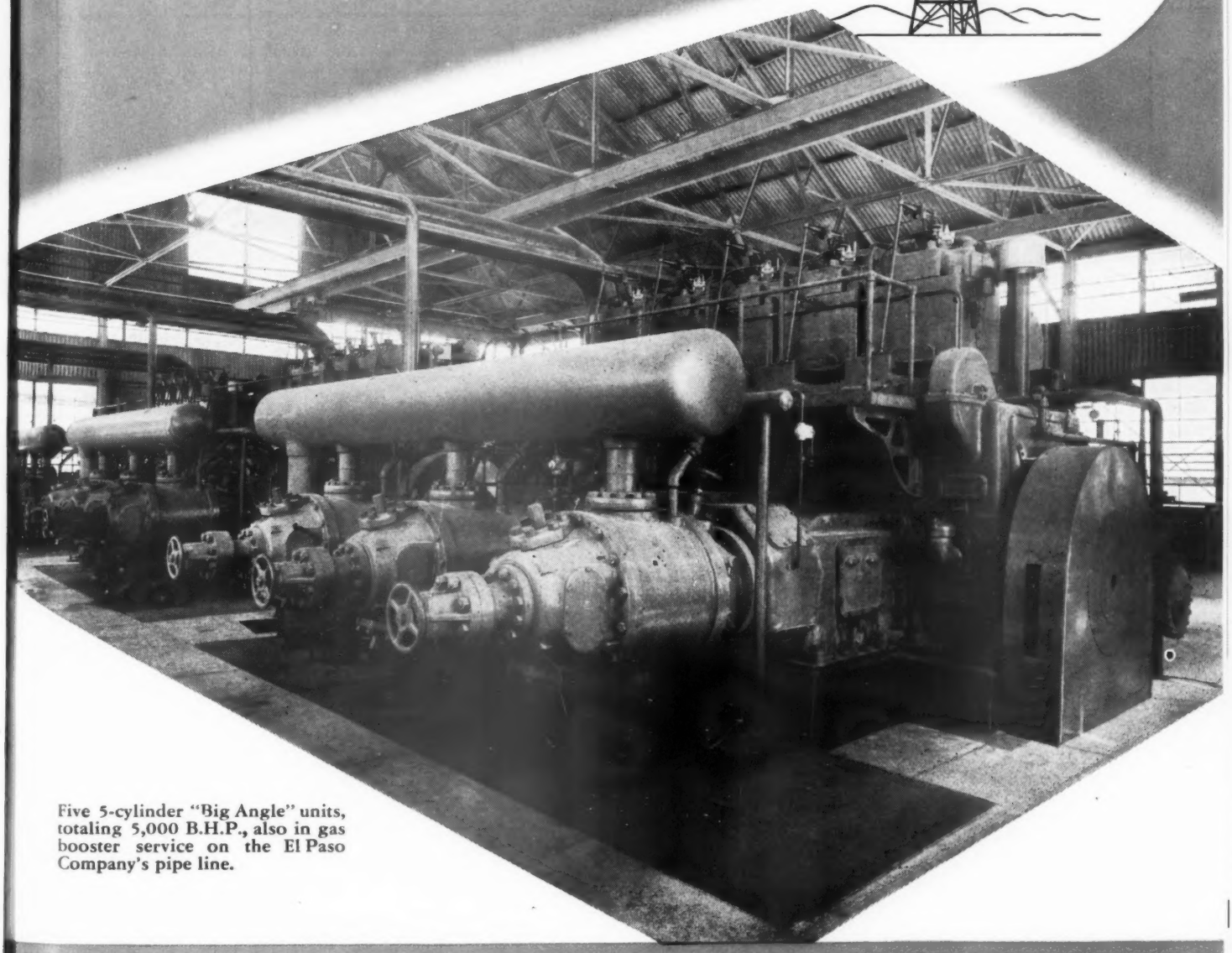

Five 5-cylinder "Big Angle" units, totaling 5,000 B.H.P., also in gas booster service on the El Paso Company's pipe line.

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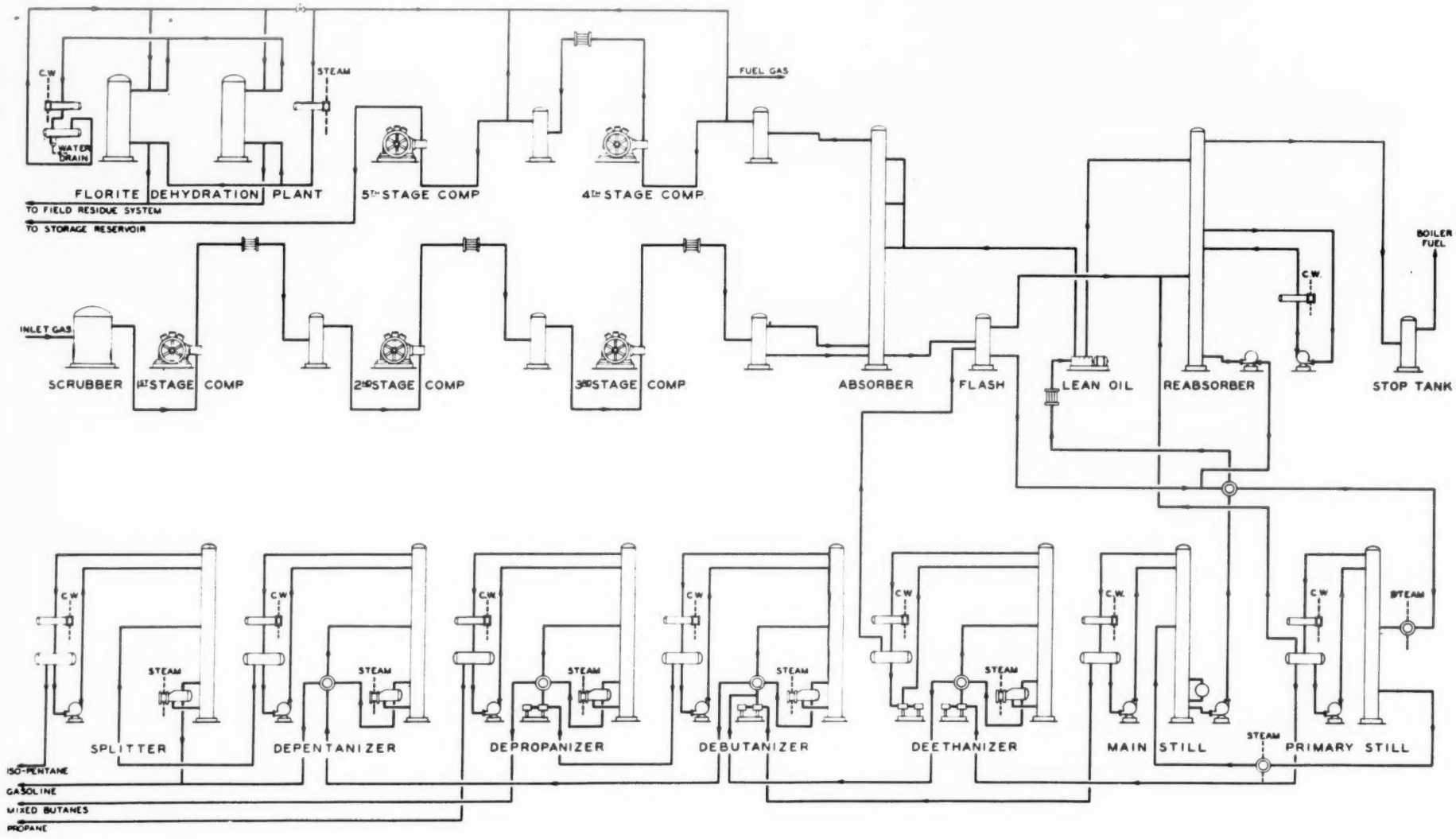

NOTE—
SPLITTER MAY OPERATE ON EITHER BUTANES OR PENTANES.
COOLING WATER IS DENOTED BY C.W.

PROCESS FLOW DIAGRAM

PATENT APPLIED FOR
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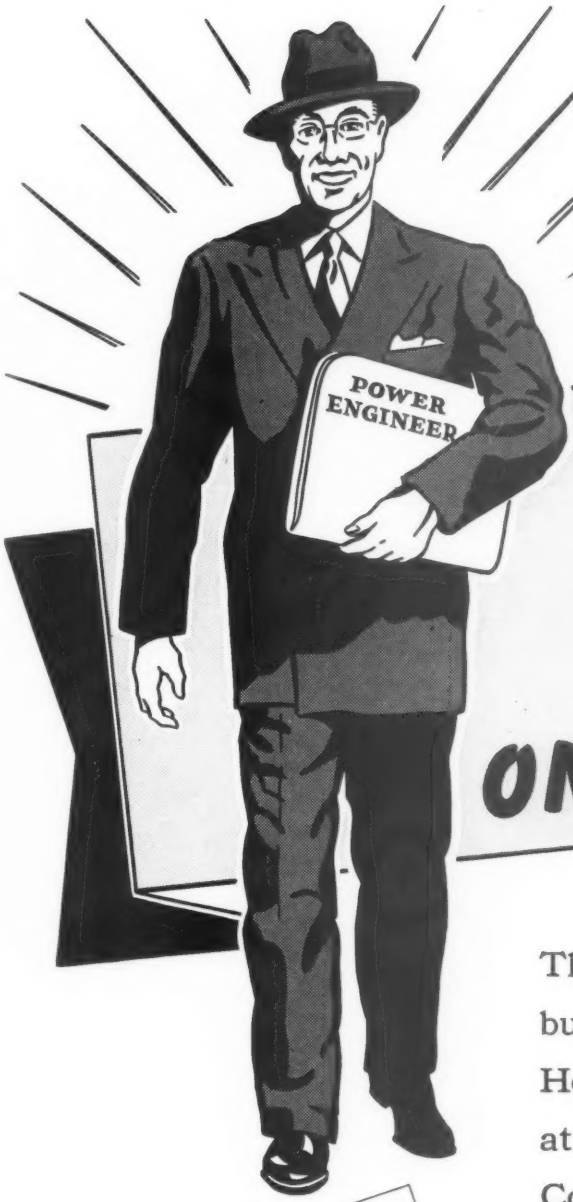

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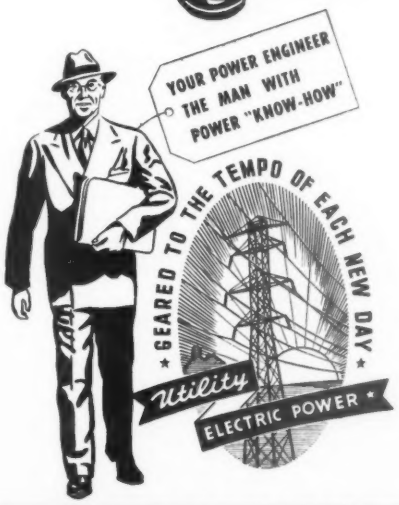

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due gas compression. This gas is dehydrated at 1600 psi in a solid type adsorbent plant. The unit has a capacity of 10,000,000 cu ft, although currently only 6,000,000 to 9,000,000 cu ft a day are being dehydrated. The discharge from the second stage of residue gas compression is delivered to a gas storage well at pressures ranging from 3500 to 5000 psi for storage in the proper sand.

● **Absorption.** The main gas flows from the wet gas compressors to the two absorbers, which are so arranged that lean oil may be introduced at the 20th, 30th, and 40th trays. This has been done so that experimental data may be accumulated on a full plant scale. The rich oil stream from the absorbers merges with the condensate from the wet gas compression accumulators in the fat oil flash tank operating at 250 psi pressure. The vapor from this tank passes to the reabsorber, operating at 185 psi. The rich oil from the fat oil flash tank combines with the rich oil from the reabsorber and flows through the heat exchangers and steam preheater to the primary still or stripper and then through a reheater to the main still.

The lean oil from the main still is pumped through the shell-and-tube main

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ELWOOD M. PAYNE

oil exchangers, heating the rich oil, then through lean oil coolers, which are atmospheric cooling sections placed in the cooling tower. From this point the multistage lean oil pumps deliver the lean oil to the absorbers. A bleed-off from the multi-stage pumps provides lean oil at the proper pressure for the reabsorber. Dry gas from the reabsorber provides fuel gas for the boilers.

● **Distillation.** The entire rich oil stream is taken into the primary or first still of a two-still system. The first still serves to make a rough distillation that separates all the methane and ethane together with most of the propane and some butanes and heavier as an overhead product, leaving the heavier gasoline components and absorption oil as a bottom product. This bottom product is sent to the main still through a second steam heater. No direct-fired heater is used.

The overhead from the primary still is fed to the deethanizer where methane and ethane are removed, with a minimum loss of propane. The bottoms from the deethanizer, consisting only of propane and heavier, join the overhead product from the main still to constitute the feed to the debutanizer.

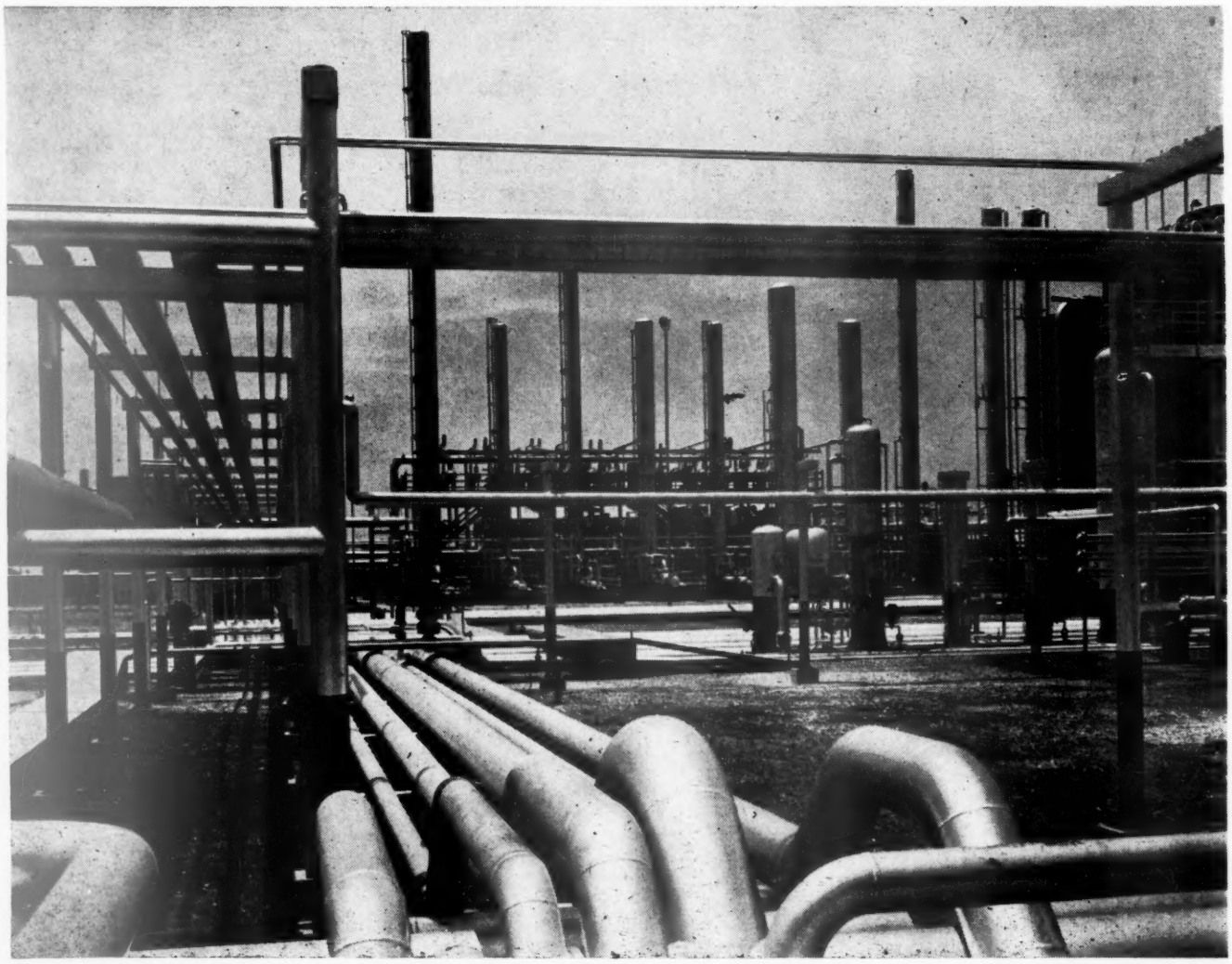
A side stream from the primary stripper is sent to the oil purifying unit, which maintains the lean oil at a constant molecular weight through clearing it of lubricating oil and other impurities. The clean oil from the oil purifying unit goes to the base of the main oil still.

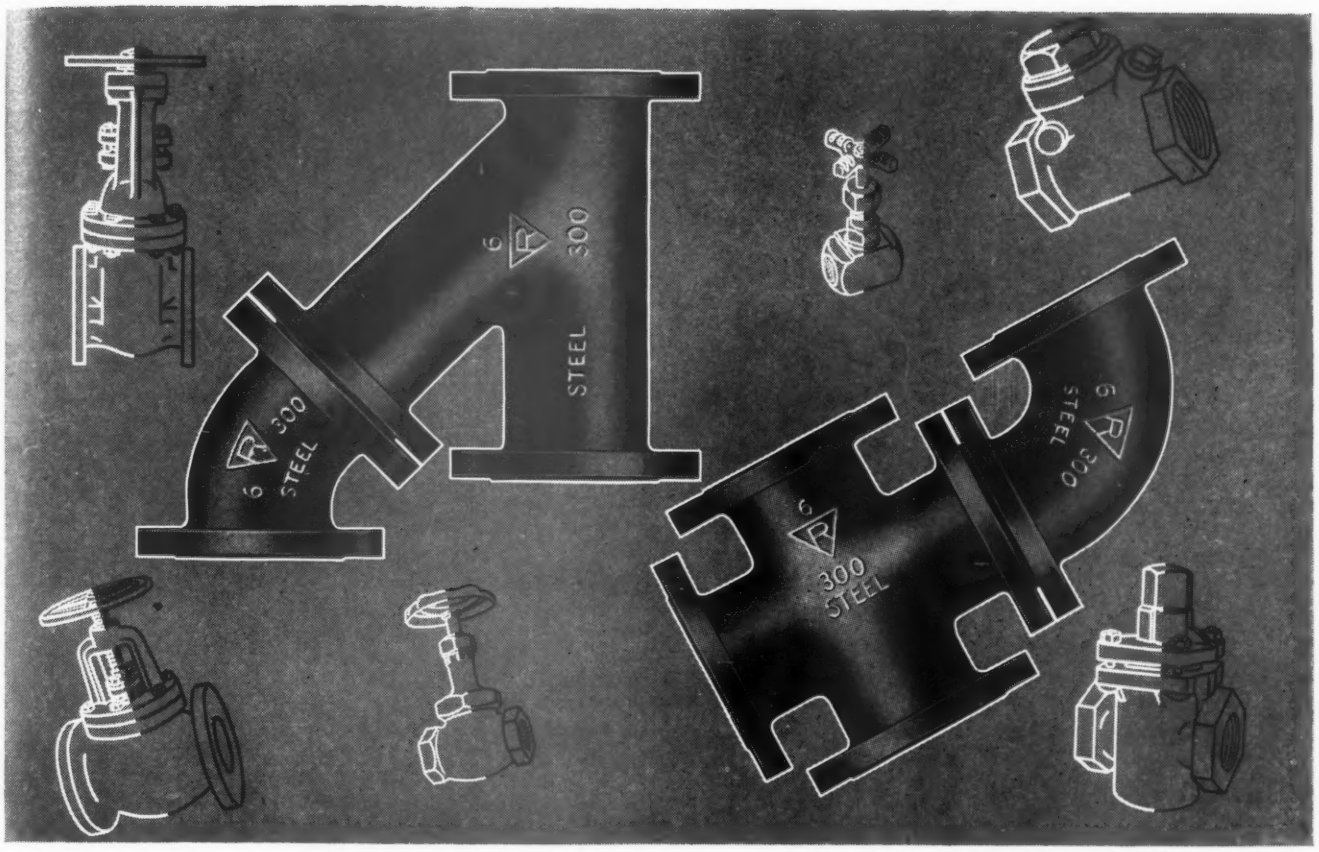
The main still removes the butanes and heavier from the absorption oil.

● **Fractionation.** The overhead from the main still is condensed and pumped as feed, along with the deethanizer bottoms, to the debutanizer operating at a pressure of 115 psig. The debutanizer removes propane and butanes as an overhead product, making debutanized gasoline as a bottom product.

If isopentane as a separate product is desired, the bottom product is sent to the depentanizer where the pentanes are removed as overhead and the bottom product is substantially hexanes plus. The overhead product, after condensation, is fed to the splitter where isopentane is separated as the overhead product. Reblending the normal pentane with the hexanes plus produces a gasoline of low

View showing piping carried on ground piers and overhead.





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vapor pressure, which may be brought up to usual vapor-pressure specification by the addition of butane.

The overhead product from the debutanizer, consisting of propane and butanes only, is fed to the depropanizer where commercially pure propane is separated as an overhead product. The bottoms, consisting of mixed normal and isobutane, is used as such or may be separated into pure iso- and pure normal butane by passing it through the splitter. Obviously, while the splittter is being used in this way, it cannot be used at the same time for separating pure isopentane as described.

Shipments of all products may be made from a rail loading rack on the nearby Santa Fe railroad and/or from a truck loading rack at the plant. Products are transferred from the plant to each loading point through a separate system of shipping pumps designed to handle butanes, propane, gasoline, and special products.

● **Manufactured products.** The plant is capable, based on processing 30,000,000 cu ft of gas a day, of the following recoveries (but not all in pure products at the same time):

Propane	60 per cent
Isobutane	90 per cent
Normal butane	95 per cent
Isopentane	90 per cent

The plant is designed to produce approximately:

360 bbl a day of propane.

400 bbl a day of butanes (47.4 per cent isobutane).

655 bbl a day of debutanized gasoline, of which 108 bbl is isopentane, which may be produced as a separate product.

Steam is generated in three integral furnace boilers. Each boiler will supply 30,000 lb per hr of steam at a pressure of 400 psi and 680 F temperature, and operates under fan induced draft. Process steam is supplied from this source at 400 psi, and indirectly through various direct acting pumps, turbines, and make-up regulators into auxiliary steam systems operating at pressures of 90 psi and 30 psi. The reboilers for the depropanizer and splitter are served from the 30-psi system. The debutanizer, dependanizer, and deethanizer use 90-psi steam. The oil purifier and rich oil preheaters and reheaters use 400-psi steam. Agitation steam to the primary still is throttled from 400 psi.

The 400-psi system also supplies steam to the turbine generators (which run condensing), the turbines on the boiler feed pumps, the turbines driving the hot and cold jacket water pumps and the induced draft fans, all of which exhaust into the 90-psi or 30-psi systems.

The 90-psi system supplies steam for the deethanizer feed and reflux pumps, the depropanizer feed, and the debutanizer feed pumps. All steam condensed in the stills and accumulators and from the reciprocating pumps is returned to the boiler feed water tank through a skimmer tank and a filter in series.

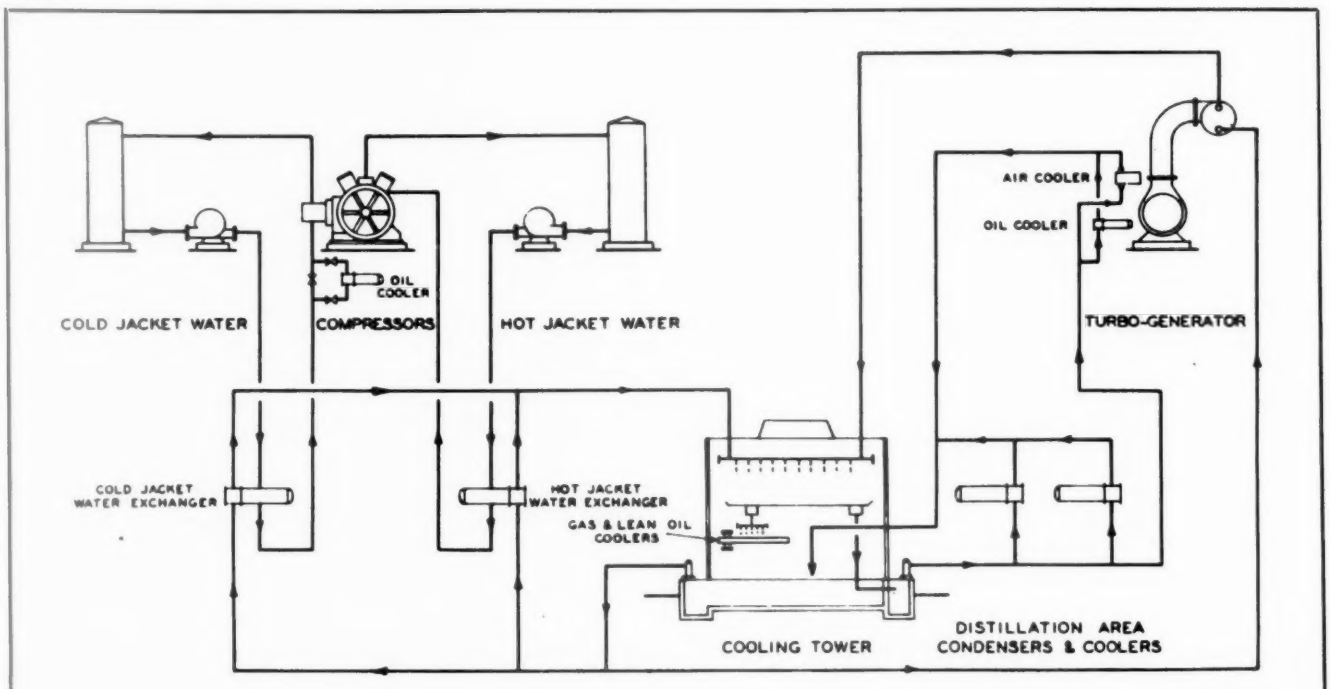
The make-up for the steam generating system is produced in a feedwater evaporator. The make-up water goes to a raw water deaerator then to the evaporator. Steam produced in the evaporator goes into the 30-psi steam system, and is used for process heating. All steam used throughout the plant is condensed and returned to the boiler feed tank. Transfer pumps supply condensate from the boiler feed tank to the boiler feed deaerating heater and reservoir. The boiler feed pump supplies water to the boilers from the deaerating heater.

● **Electric power.** Plant electric power is generated by three 750-kw condensing turbo generators. Each unit consists of a multi-stage, condensing turbine driving a 750-kw at 80 per cent power factor, 3-phase, 60-cycle, 480-volt, 3600-rpm generator. Two operating units supply all the plant requirements while the third unit is spare. An emergency gas engine-driven generating unit is set up in the boiler building to automatically provide emergency lights in that building should a power failure occur in the main generators.

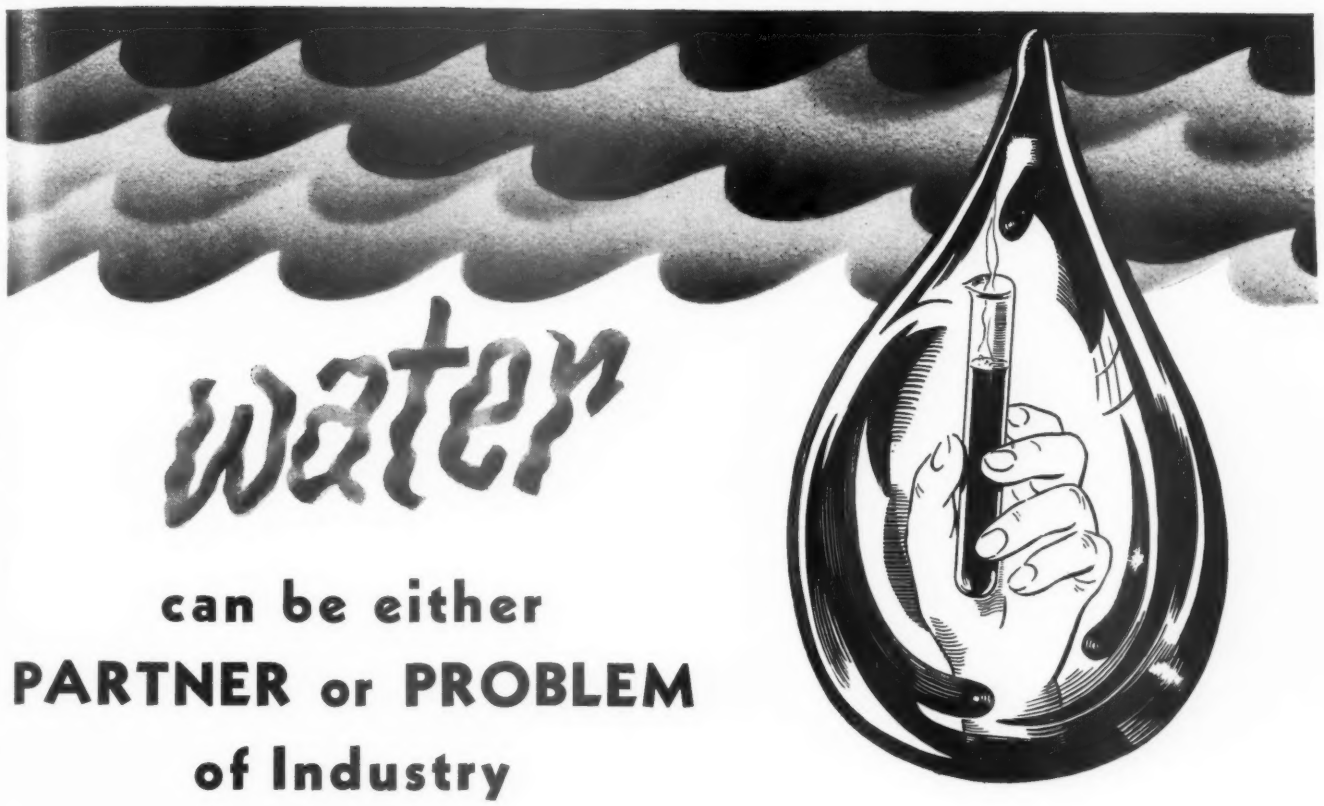
A fully enclosed switchboard houses the controls and switching equipment for the three main generators, and distributes energy to the main control center and distribution units.

A feature of the switching arrangement is the provision of two separate bus systems into the plant yard. The vital operating pumps are carried on both buses so that in the event of feeder or switch failure they may be transferred to the bus not interrupted. The main control panel for the pumps operating in the distillation area is placed in the main distillation structure and the equipment is of explosion-proof design. There are also control centers at the cooling tower and at the shipping pump house. Lighting is handled through a 208/120-volt, 3-phase, 4-wire system. Main power leads are carried underground in fiber ducts laid in concrete. A few power leads are in painted, protected rigid metal conduit.

A complete telephone system throughout the plant ties in all operating units with the plant switchboard. The instruments situated in hazardous areas are of the explosion-proof type.



COOLING WATER SYSTEM



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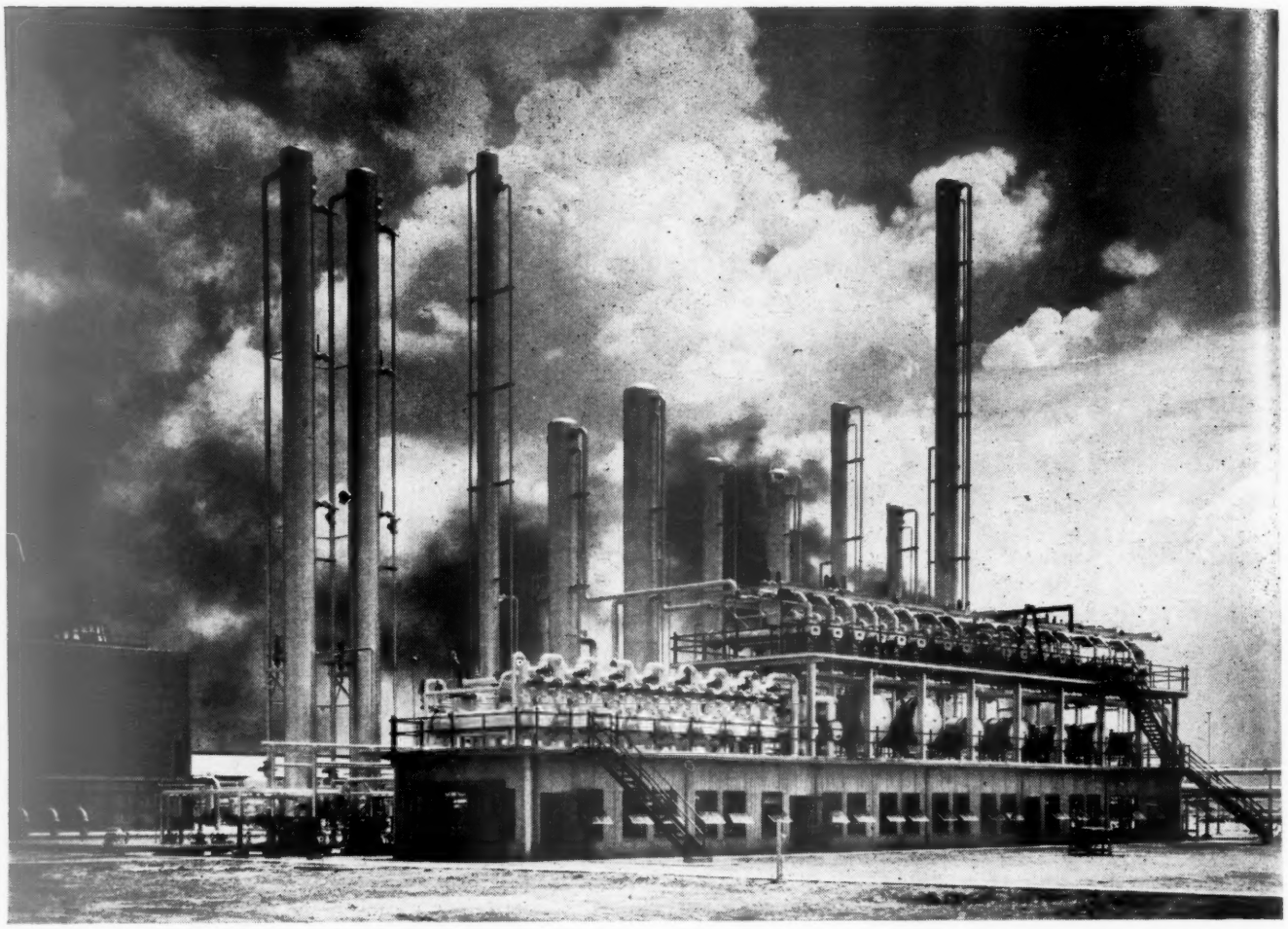

Three-floor distillation structure showing coolers on top floor, main oil exchangers and accumulators on second floor, and enclosed pump room on ground floor. Vessels left to right are absorbers, reabsorber, primary still, main still, deethanizer, debutanizer, depropanizer, dependanizer, splitter. The three points of injection for lean oil in the absorbers are clearly shown.

● **Product storage.** The product storage at the plant consists of two 750-bbl 10 ft by 55 ft horizontal tanks with a working pressure of 60 psi for natural gasoline make tanks, six of the same type except they are 225-psi working pressure for propane and LPG storage, seven of the same except for 160-psi working pressure for storage of butanes, and two 5000-bbl Hortonspheroids for storing 26-lb Reid vapor pressure gasoline. Each spheroid is provided with a propeller type mixer agitator near the bottom.

The horizontal tanks are manifolded for multiple purpose within their individual pressure ranges. This allows for product storage flexibility when changing product specifications according to sales requirements.

● **Compressor installation.** Nine 1000-hp angle type compressors are installed to handle the wet gas into the plant. These engines are designed to handle approximately 31,000,000 cu ft at a minimum pressure of 9.8 psia to a pressure of 715 psia through three stages. The gas from the third stage goes, after cooling, to the high pressure absorbers.

Each of these engines has four compressor cylinders: Two 25-in. diam, one 18½-in. diam, and one 10-in diam. The design capacity for these machines is:

Suction, psia	Discharge, psia	Capacity/24 hr cu ft
9.8	715	30,870,000
23.9	715	40,000,000

Each of the wet gas units is equipped so it may be unloaded over a wide range of suction pressure, as indicated in the table. This is accomplished by pressure-operated unloading valves that are controlled manually from a single station.

The gas inlet to the machines is through two main inlet scrubbers that are arranged to separate liquid and slugs of oil. They are preceded by buried drip tanks installed on the incoming field lines. A 30-in. pipe header interconnects the scrubbers and serves as the first-stage suction header. Each stage is separately cooled after compression and the condensate is removed by a separator tank.

An interesting feature of the wet gas compressor system is the fact that the system is arranged with block valves so it may be completely separated into two parts, and so that four engines operate on one side and five on the other, each with its separate inlet scrubber, coolers, and separators.

Residue gas from the absorbers is led to three 800-hp. angle type compressor units designed to handle approximately 26,500,000 cu ft through the first stage at 700 psia suction and 1570 psia discharge. If more than 700 psi pressure is required, the field residue gas can be taken from the first stage, and the second stage handles the remaining gas to a discharge pressure of 3515 psi to a maximum of 5000 psi. Interstage cooling and condensate separation is provided on the fourth stage discharge.

Due to the pressure and capacity requirements of the residue gas compressors extreme flexibility is essential. The capacity of the machines may be varied by clearance pockets in the cylinders. and the first stage also has suction valve lifters. The second stage cylinder clearance may be further varied by screwing the piston in or out.

The design capacity for the residue gas compressors is as follows:

	Suction, psia	Discharge, psia	Capacity/24 hr, cu ft
First stage	700	1570	26,500,000
Second stage	1567	3515	18,000,000
First stage	700	1871	21,870,000
Second stage	1868	5000	14,880,000

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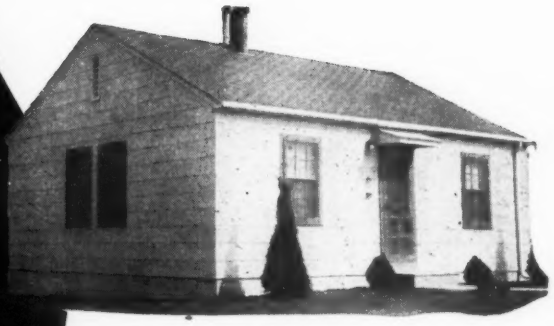

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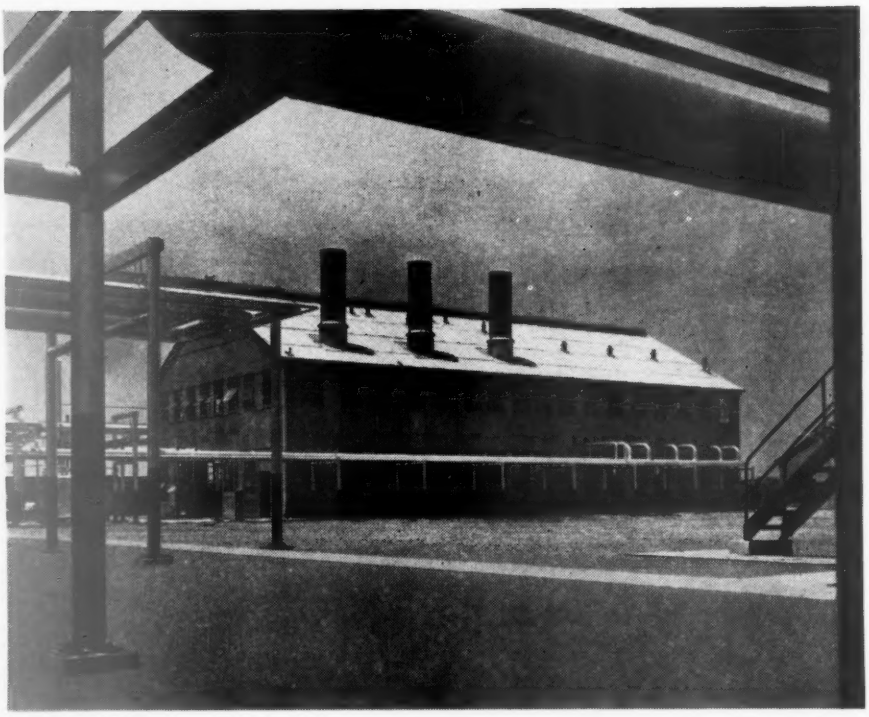
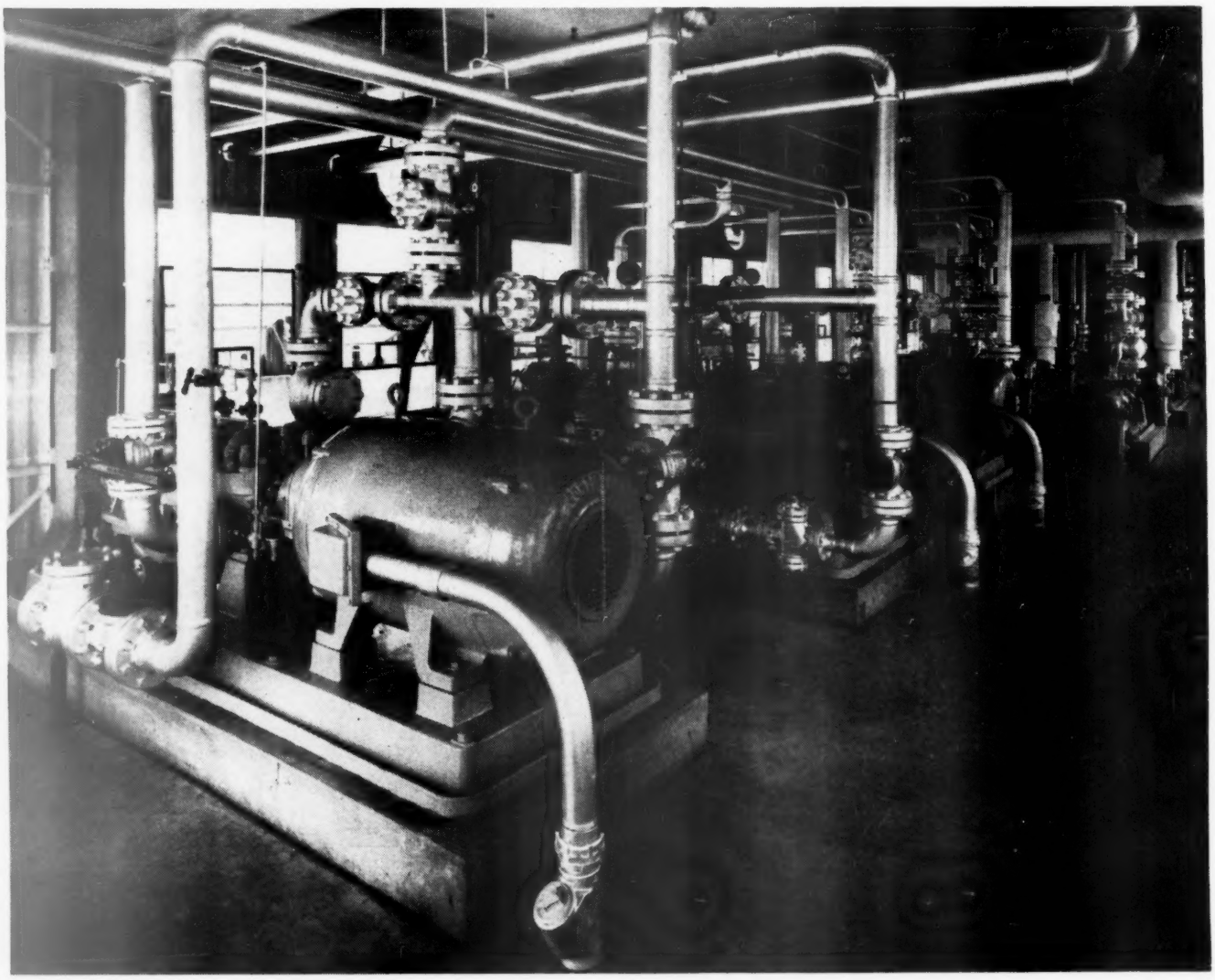


View No. 9, boiler house. Cooling water headers serving turbo generator condensers at right of boiler house. Steam headers at the left.

● **Cooling water system.** The cooling system for the plant centers in a 12-bay double flow, induced draft cooling tower, which is placed about midway between the compressor building and the distillation structure. Two complete cooling systems are handled by the tower. One system provides cooling water at 100 F from the basin of the tower to the shell-and-tube coolers for the compressor jacket water and oil cooling systems and to the turbo generator condensers. This water is returned over the top of the tower. The second system takes water from the collector deck at 85 F to supply the coolers and condensers in the distillation area, and the oil cooling equipment for the turbo generators in the boiler house. The second system discharges into the cooling tower basin.

The main cooling in the plant is done in shell-and-tube coolers. The only ex-

Pump room showing high pressure lean oil pumps with distillation pumps in background.



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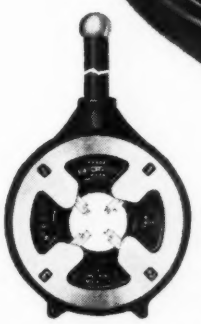

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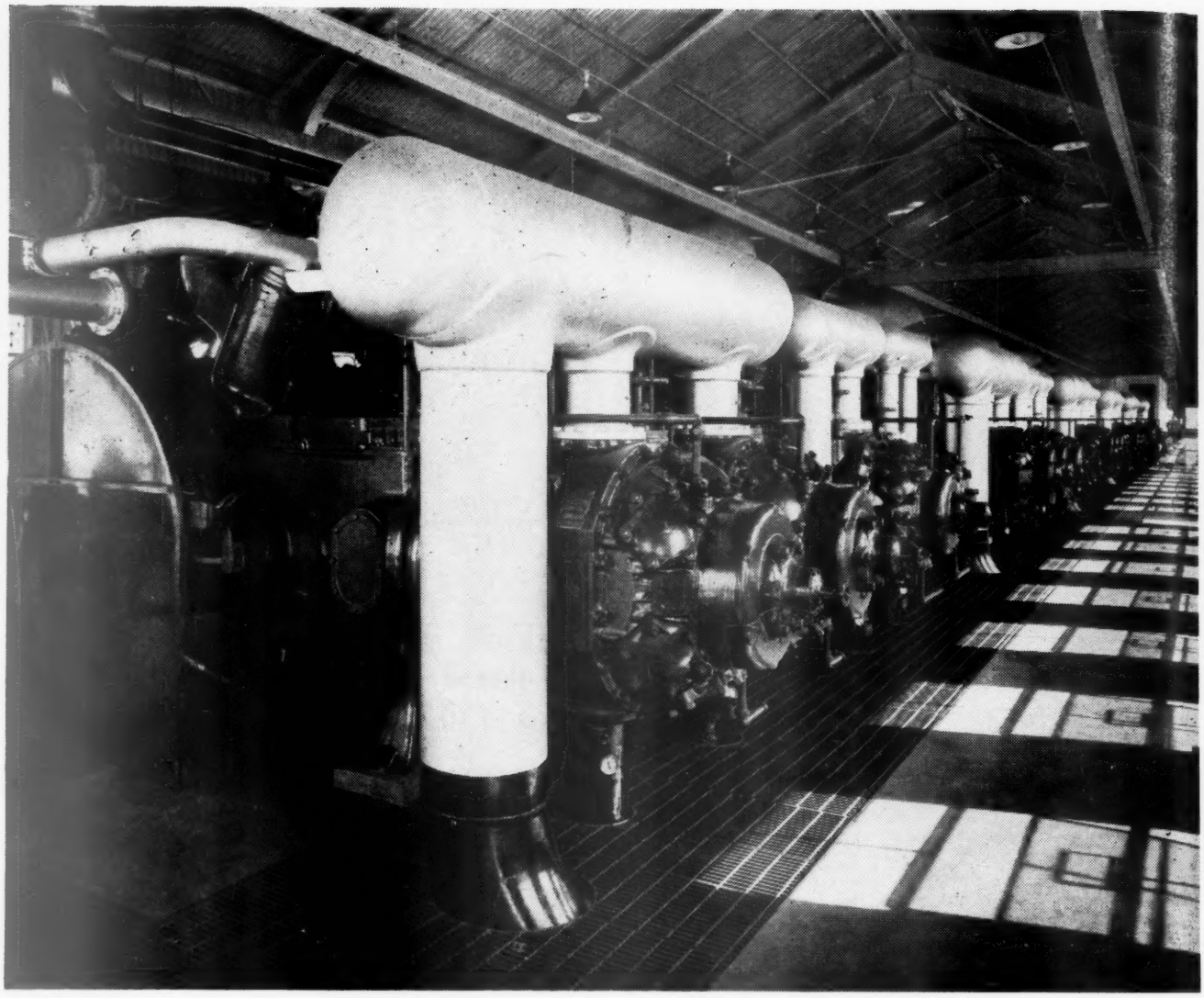
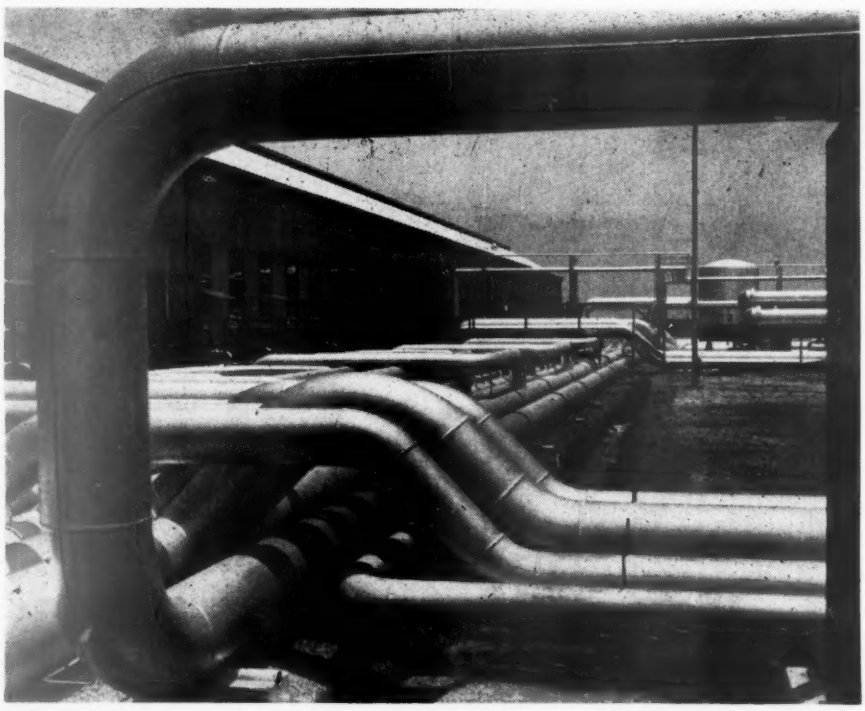


Compressors at Stanolind plant at Hastings field.



Compressor gas headers shown with inlet scrubber in background. Jacket water and lubricating oil heat exchangers, are seen at extreme right.

ceptions to this are the first, second, third, and fourth stage compressed gas interstage coolers, and the lean oil coolers. These are all atmospheric cooling sections placed in a coil shed in the lower part of the cooling tower. The compressor cooling is handled in two separate closed systems. One system cools the lubricating oil and the compressor cylinders in series flow, whereas the second system supplies cooling water to the compressor power cylinders. The two systems have their own pumps and water from each circulates through the shell side of a shell-and-tube cooler, delivering heat to water circulated from the cooling tower basin. The range of cooling for the engine jacket water is 155 to 145 F, and 127 to 110 F on the lubricating oil. The flow sheet indicates the water flow in the various systems.

● **Piping.** One unusual feature of the piping is that it is all carried above the

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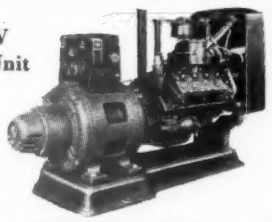
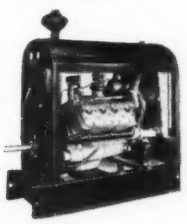
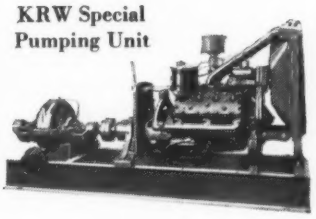




KRW Special Pumping Unit



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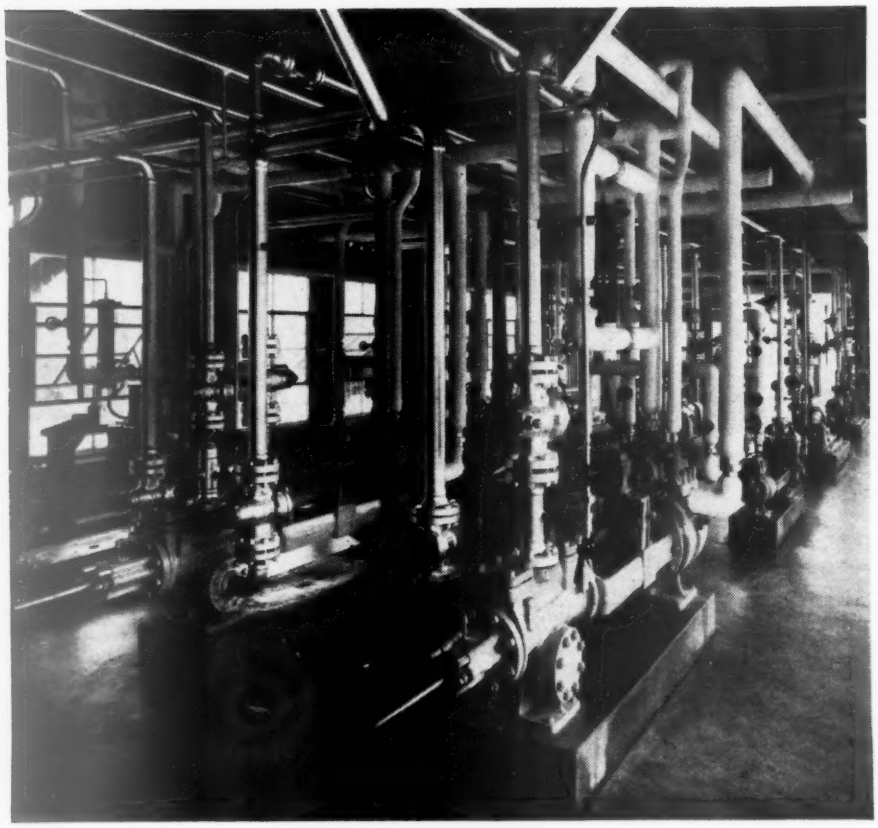


Ground floor of distillation structure showing fractionation pumps.

ground, including even the water piping. The only exceptions are the drains and sewer lines.

The header piping in front of the compressors is carried on pipe piers, and the piping from the compressor headers to the cooling tower is similarly supported. The number and size of these pipes is clearly shown in the illustrations. From the cooling tower to the distillation area and boiler house the piping is largely carried upon elevated pipe supports in two decks.

The piping in the plant follows the standards for "Inside Refinery Limits" piping as given in the A.S.A. Code for Pressure Piping, Section III.

The aboveground piping minimizes corrosion and places the pipe where inspection and maintenance are easy.

● **Foundation designs.** The maximum water level to be expected at the plant site during floods was established from records and observation. All building foundations were carried above this level, thus insuring that the working areas would remain above water even though the plant yard might be flooded.

Due to the poor character of the soil in the area an intensive soil investigation was made. Undisturbed corings were made over the entire area and subsoil logs plotted. A complete set of unconfined tests was made. Consolidation tests were made of three samples from two 45-ft core holes. These covered the first, second, and third strata below the organic top layer.

It was of particular interest to study the action of the soil under vibrating loads, such as under the compressors. The consolidation tests indicated that adequate bearing could be obtained at a depth of 6 ft on the east end and 8 ft on the west end of the compressor building, which is 411 ft long. Accordingly, the mat was divided in two parts, set at two elevations. To insure uniform loading at the ends of the mat, the mat under the end blocks was tapered.

The walls of the compressor building are not tied into the mat for the compressors but are kept separate. The space between the blocks and the walls is filled with tamped dirt. No credit is given to this soil for floor bearing. The floor and trench walls are supported on a series of short piers. To avoid transmitting vibration to the floors from the compressor blocks, rubber insulators are inserted where the floors rest against the blocks and where the trench walls contact the blocks. This has minimized vibratory effects in the floor slabs.

The foundations for other buildings in the plant have been carried to the soil indicated for best bearing, with unusually wide footings to distribute the building loads.

The University of Texas, Soil Mechanics Department, under Prof. Raymond F. Dawson, has installed special reference monuments at the plant site with bronze plugs set in various parts of the foundations for accurately determining the settlement of all structures. To date the rate of settlement has agreed very well with the calculated rate.

● **Buildings.** Buildings are of structural steel with corrugated asbestos covering. All buildings are arranged for maximum ventilation and are constructed so that screens may be installed over all openings.

The compressor building, 32 ft wide by 411 ft long, and the boiler building, 54 ft wide by 101 ft long, are of rigid frame construction. This type of structure provides an unusual amount of clear space and presents a clean, attractive interior.

The distillation structure is unusual in gasoline plants. The structure itself is a rigid structural steel frame that has three floors or levels. On the top floor are placed the vapor condensers for the various fractionation vessels. The floor of this level is of heavy expanded metal. On the second floor are placed the accumulators for the respective condensers. A portion of the second floor carries the main oil exchangers. The second floor is of reinforced concrete.

All pumps for the distillation and absorption equipment are housed on the ground floor, which is completely enclosed in corrugated asbestos with adequate doors and windows. Auxiliary ventilating fans are installed in the pump rooms. The main instrument room is in the center of the ground floor and divides the pump floor into two operating rooms. The process control instruments are arranged around the walls of this room, providing a compact, centralized control area.

The arrangement of the structure assures constant and ample heads of liquid to all pumps. The design provides for the shortest and most direct vessel-to-pump piping through the coolers and accumulators. The direct downward flow eliminates any possibility of slugging and facilitates smooth control.

An 8200 sq ft office building was erected just outside the plant area proper. This building is of one-story brick construction and serves to house the production and operating office personnel for the area. This building is completely air conditioned.

The fire pump, change room, meter, and other small buildings are conventional steel structures covered with corrugated asbestos.

● **Fire protection.** The plant is protected from fire through two fire systems. One system operates at 150 psi and provides 750 gpm of water for ordinary hose nozzle service. Two pumps are provided, one electric motor-driven and one gasoline engine-driven. The high pressure fire system pump provides 80 gpm of water at a pressure of 700 psi for fog nozzle service. Five remote control stations at widely separated points in the plant are provided for this system. Conventional CO_2 gas extinguishers are provided at convenient locations throughout the plant.

● **Construction contractor.** The Stearns-Roger Manufacturing Company of Denver, Colorado, engineered and constructed the complete plant in collaboration with the engineering department of the Stanolind Oil and Gas Company.

★★★

Fundamentals in the design of rock bits*

By WILEY B. NOBLE, Reed Roller Bit Company

● **Foreword.** This paper is divided into two parts, the first part being of general interest to those engaged in the design of a product from the dimensional and materials standpoint; whereas, the second part of this paper is of greater interest to those concerned with the functional results obtained when using a rock bit. The reason for the selection of such a subject is that it is believed that most of you men sometime during your drilling careers have felt the desire to design a new or better rock bit; and it is hoped that, if in some way, we can set out some fundamental guide posts for your consideration, it will help with the job in the future.

PART 1

The fundamental and most confining of all considerations in the design of any rock bit is simply one of space or room. It must be kept in mind that in the design of a rock bit, every part of the bit that digs the hole must be contained inside the diameter of the hole. This merely means that every element of a rock bit that digs an 8¾-in. hole must be inside an 8¾-in. diam circle. This fact can be contrasted with the problems of a designer of a dragline. If a designer finds that one of the shafts of a dragline is too small or that the key-ways are battering out, he can increase the size, as he has the room in which to operate; but if the performance records indicate that a design change is necessary to strengthen one of the component parts of a rock bit, the designer is faced with the problem of limited space. For example, if a larger diameter cutter is indicated, this change can be accomplished only by compromise with other parts in the bit. Space consideration can more clearly be seen by looking at Fig. 1, in which is illustrated the clearance between cutters of a bit. It is evident that if the outside cutter is made wider by moving its inside face over to the dotted line "A-A," that the radius of the second cutter must be made smaller a corresponding amount, this being shown by the dotted circle of diameter "D_1." This condition would favor the outside cutter considerably, for a greater roller bearing capacity could be placed under it, and the second cutter would be weakened to the danger point. It might occur to some of you that the outside cutter could be made larger in diameter, as illustrated in Fig. 2. This could be done; but here again trouble would result. The outside cutter would contact the wall of the hole in two spots causing early and premature wear. Further, the excessive diameter would cause cramping of the outside cutter bearings and quick failure would result. From these two figures it immediately becomes apparent that the design of a rock bit is one of intricate balance between the diameters, lengths, and angles of the axes of the cutters.

The consideration of space is not only important in the geometry of the bit, but is important with respect to the inside construction of the bit; that is, the parts you never see, such as shell thickness, bearing diameter, and journal diameter. This is shown in Fig. 3, in which several examples are illustrated showing an enlarged view of the sections taken through various cutters. In the design of a cutter of a specific diameter, the designer is faced with four considerations; namely, tooth depth, shell thickness, bearing diameter, and journal

*Presented before American Association of Oilwell Drilling Contractors, Long Beach, California, October 13-15, 1947, under the full title of "Fundamental Considerations in the Design of Rock Bits with a Discussion of Laboratory Data on Effect of Weight and Rotary RPM on the Drilling Efficiency of a Rock Bit."

The Author

Wiley B. Noble, vice president and chief engineer, Reed Roller Bit Company, Houston, Texas, is a graduate of Rice Institute, receiving a mechanical engineering degree in 1935. He began his connection with Reed in the patent department, progressing through the engineering department from draftsman, field engineer, development engineer, assistant chief engineer, war products engineer, to his present position.

FIG. 1. Clearance between cutters of a rock bit.

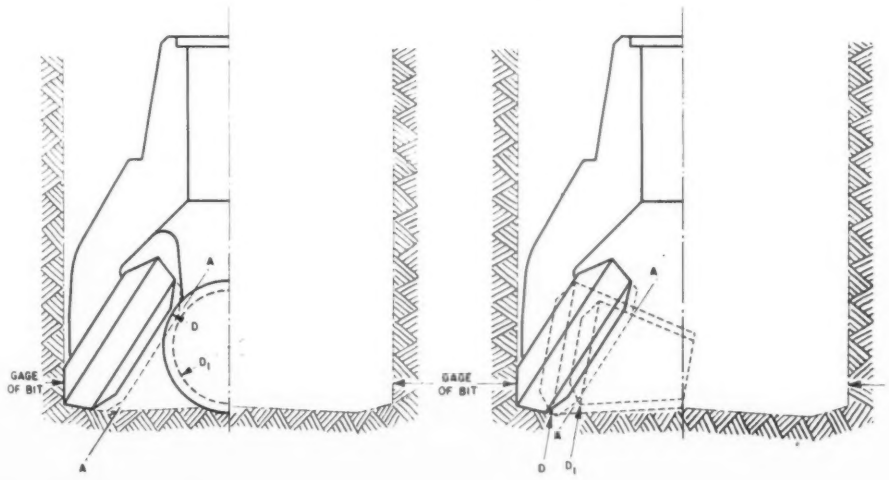
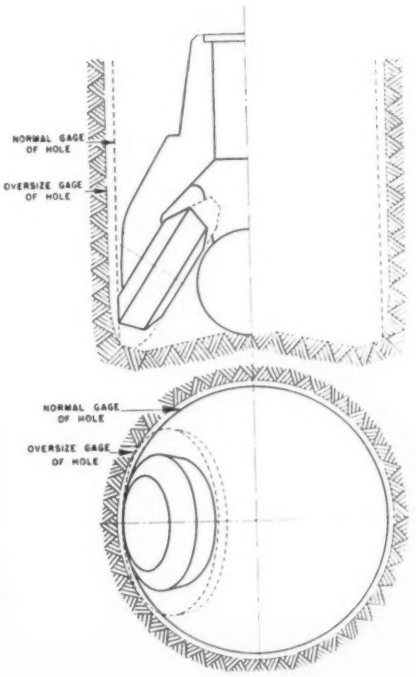


FIG. 2. Effect of oversize outside cutter diameter on size of hole.



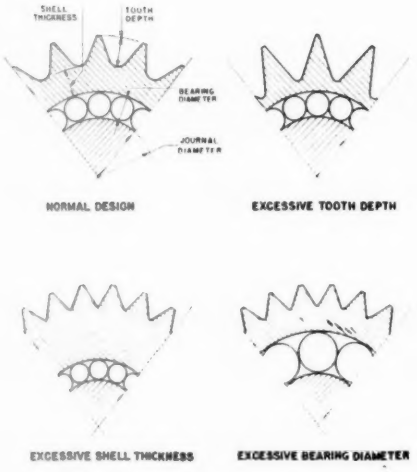


FIG. 3. Effect of excessive tooth depth, shell thickness, and bearing diameter on rock bit cutter design.

1. Space requirements.
2. Materials.
3. Tooth design.
4. Hard metal—selection and application.
5. Bearings.
6. Tolerances.
7. Surface finish of working parts.
8. Frame of bit forgings, castings, weldments, etc.
9. Nozzle assembly.

FIG.4. Fundamental considerations for rock bit design.

diameter. Here again the designer is faced with the problem of spacing or balancing. It clearly can be seen that if he favored the teeth by making them very deep, he reduces the shell thickness, bearing diameter, or journal diameter. If he favors shell thickness, he does so at the expense of one or all of the other three elements; or, if he favors bearing diameter, then he still penalizes one or all three of the other elements. This figure serves to illustrate that the designer must have the proper balance between tooth depth, shell thickness, bearing diameter, and journal diameter, in order to arrive at a bit that gives you the maximum bit life.

Once the designer has completed his work on the drawing board and has what he considers to be the best balanced design from which to build a bit, he is then faced with the problem of materials. He knows from the very outset that the best materials obtainable will not be as good as he wants or needs, due to the ever-increasing need for longer bit life, combined with the need for greater penetration.

His next consideration is in the proper heat-treatment of the steel, to obtain the hardenability, case and core physicals, necessary to produce long bit life. By case is meant the hardened surfaces of the component parts that have had their carbon concentration raised by carburizing to the point where they will give maximum resistance to wear. The core found in the component parts is the foundation on which the case rests and must be considerably softer than the case in order to retain the ductility necessary for long bit life. The designer must know that the steel has been considered and approved by the metallurgical department, for it is not pleasant to face a bit failure at a later date—not because his designing was poorly done, but because the basic inherent physical properties of the steel were not what he expected.

We have discussed only two considerations which affect the design of the bit and the materials to be used in it but there are many more. The designer must be constantly aware of such conditions as are listed in Fig. 4. We hope that this list of design considerations, and the brief discussion of several items above, may in some way help you to understand that all designers working for bit manufacturers are striving every day to give the drilling contractors a better product.

PART 2

It is our desire to bring to you contractors some data on the performance of a rock bit that will establish the fact that there is an optimum weight and an optimum rotary rpm for maximum drilling efficiency. Unfortunately, we are not able to bring you data taken directly from your drilling rigs because the control necessary to accumulate this information must be more accurate than is possible to maintain on a contract drilling rig and, under some conditions of weight and rpm, would result in unprofitable operations for you. Because of this circumstance, over which we have no control, we were forced to resort to laboratory tests to supply you with this information.

We are often called upon to provide the ideal weight and rotary rpm for rock bits, but due to so many variables, including the human variable, we are unable to set down in chart form the weight and rotary rpm that will produce the greatest drilling efficiency in any formation. In obtaining our laboratory data, it was necessary to have a drilling machine capable of producing wide variations in drilling weights and rotary rpm and that we drill in a formation of uniform hardness. In the laboratory all variables can be controlled within reasonable limits, and pertinent data can be accumulated. It must be borne in mind that data of this nature is limited in its scope because actual field conditions cannot be duplicated in the laboratory. The data obtained apply only to the rigid conditions under which the experiments were conducted; however, we would like to point to the consistency of the trends found in the laboratory curves, and from this one fact we feel that a pattern can be established for varied drilling conditions.

For our experimental work we chose hard formation standard production rock bits in the 6¾-in. size. The formation selected was granite obtained from a quarry near Llano, Texas. The drilling machine was capable of producing a load of 100,000 lb on the bit and a rotary speed of 500 rpm maximum. Clear water was used as the drilling fluid. A new bit was used to drill 2 ft of hole at a given weight and rpm. After all 2 ft drilling tests were completed, the bits were then re-run until they were

FIG. 5. Effect of rotary rpm variations on rate of penetration arrived at by drilling 2 ft in granite at constant loads.

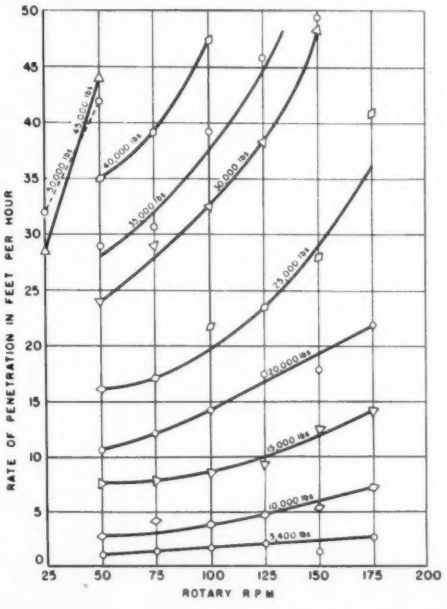
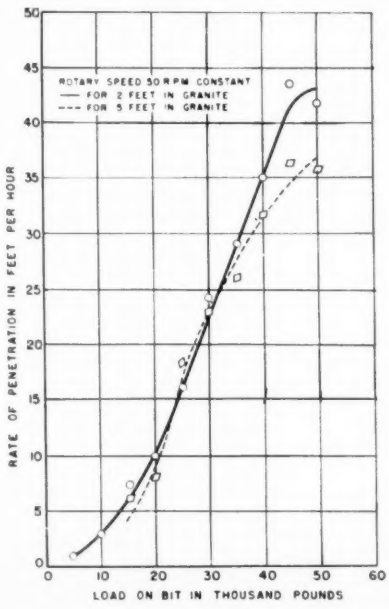


FIG. 6. Effective change in rate of penetration due to an increase in the amount of formation drilled of from 2 to 5 ft at constant rotary rpm and varying loads.


ROTARY SPEED 50 R.P.M. CONSTANT
FOR 2 FEET IN GRANITE
FOR 5 FEET IN GRANITE
RATE OF PENETRATION IN FEET PER HOUR
LOAD ON BIT IN THOUSAND POUNDS

completely dulled in order to determine the life expectancy of the bit under each drilling condition. All this data is illustrated in curves that will be explained in the following order:

The curves shown in Fig. 5 are the first steps taken in the laboratory to accumulate the data necessary to arrive at the optimum weight and rotary rpm to produce maximum drilling efficiency. They plot the rate of penetration of a bit in feet per hour vs. rotary rpm under constant loads applied to the bit. Each curve is intended to show the variation in the rate of penetration for each change in rpm when timed for a 2-ft interval.

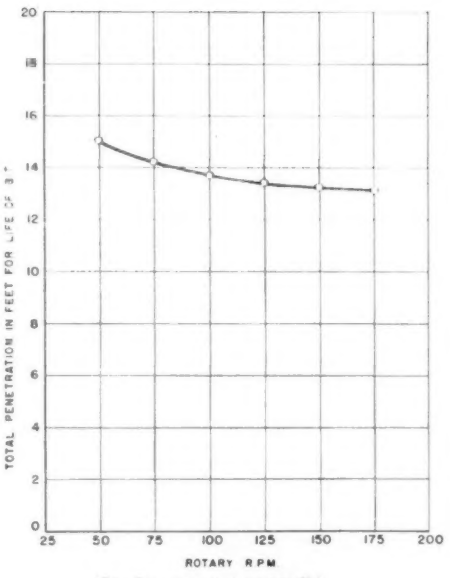
We would like to point out to you that the rate of penetration for each change in rotary rpm is increased as the 2-ft increment of drilling was not great enough to bring into consideration the effect of tooth breakage and tooth wear caused by excessive rpm and weight.

With this preliminary information in mind, we pass to Fig. 6, which contains two curves—one a solid line that shows the rate of penetration for 2 ft in granite vs. the load on the bit, while the other, a dotted line, shows the rate of penetration for 5 ft in granite vs. the load on the bit.

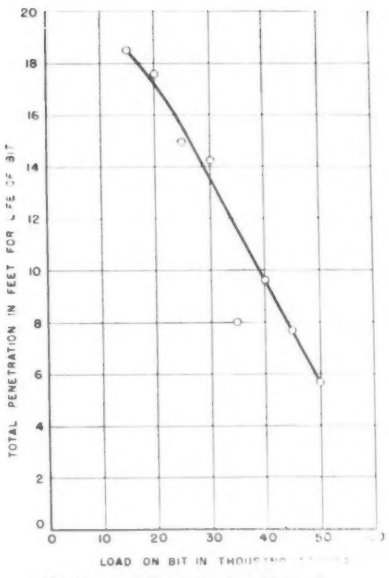
These data are presented to obtain a comparison between the life expectancy of bits run under like conditions for different amounts of penetration. It is interesting to note that the curves are practically the same unil after the application of a load of 25,000 lb. This indicates that with a constant rotary speed, the rate of penetration for a shorter interval of time is no better than that for a longer interval of time until after the application of some particular drilling weight to the bit—in this case, 25,000 lb. After this point is passed, the rate of penetration for the longer interval begins to drop off, due to excessive tooth breakage and premature dulling of the cutter teeth. This, of course, clearly illustrates that to maintain maximum rate of penetration for the longest period of time, the bit must not be overloaded to the extent that tooth breakage occurs. Here we have he first indication of an optimum weight for maximum drilling efficiency.

The question often asked is "Which has the most effect on the life of a rock bit, variation in rotary rpm or variation in weight?" The answer to this question has a direct bearing on our topic of discussion; namely, the selection of the optimum rotary speed and load to produce the maximum drilling efficiency. In an effort to answer this question, we have prepared the curves shown in Fig. 7.

These two curves were prepared by plotting total penetration vs. rotary rpm

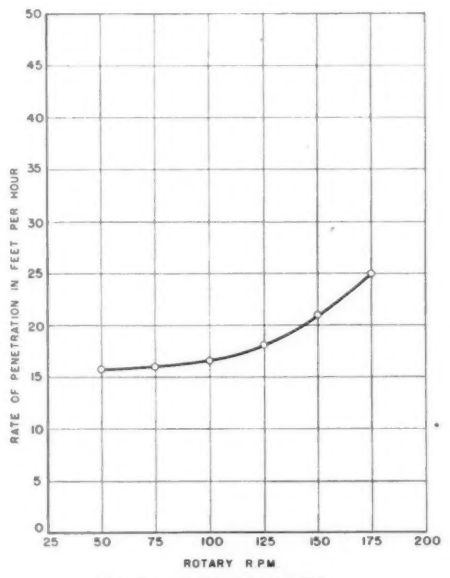


(Load constant at 25,000 lb)

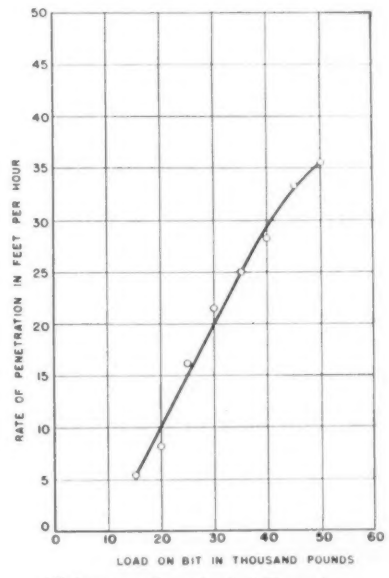


(Rotary speed constant at 50 rpm)

FIG. 7. Effect of rotary rpm variations and load variations on total penetration for life of bit.



(Load constant at 25,000 lb)



(Rotary speed constant at 50 rpm)

FIG. 8. Effect of rotary rpm variations and load variations on rate of penetration for life of bit.

in the curve on the left, and total penetration vs. load on the bit, in the curve on the right. The one on the left is plotted to show the total penetration in feet vs. rotary rpm, with the load remaining constant at 25,000 ft, whereas, the one on the right is plotted to show the total penetration in feet vs. load on the bit in thousands of pounds, with rotary speed held constant at 50 rpm. A study of the left-hand curve shows that at 25,000 lb and 50 rpm, the total footage drilled by the bit was 15 ft. At 25,000 lb and 175 rpm, the total footage drilled by the bit had dropped to 13 ft. The effect of increasing the rotary rpm under constant load from 50 to 175 rpm resulted in a decrease of the total footage drilled of 13 per cent.

The right-hand curve presents a more drastic reduction in total penetration of the bit as the load is increased. This decrease amounts to 69 per cent, with a load increase of from 15,000 to 50,000 lb. Reduction in total penetration was due to a more rapid dulling of the cutter teeth under the heavier loads. From this laboratory information it is indicated that the answer to our question is that excessive drilling weight shortens the life of a bit more than does excessive rotary rpm.

Your attention is called to the fact that no mention is made of the bearing wear produced by the higher speeds because there was no way to determine accurately what effect this would have on the life of a bit. It is known that

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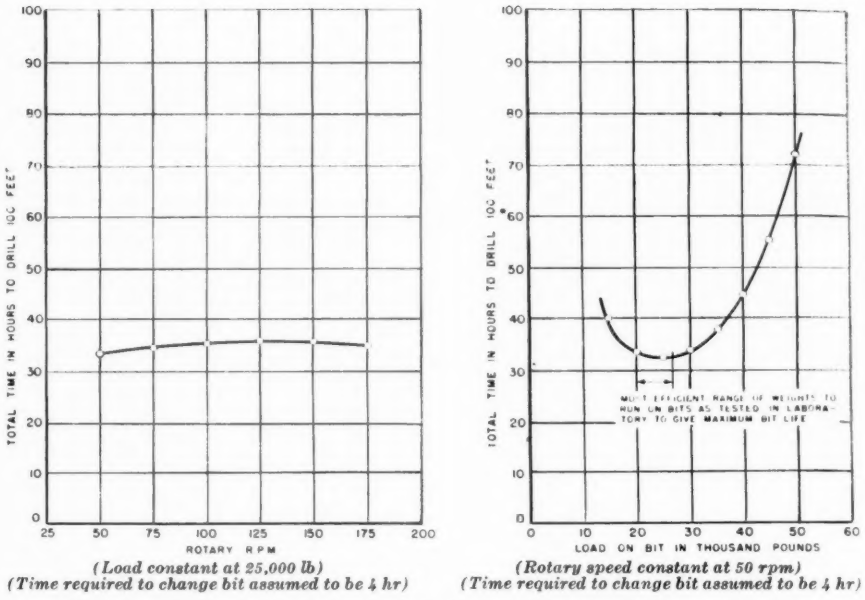
The greatest activity in the quest for new sources of oil during 1946 was seen in Oklahoma where 3000 new drillings yielded 76 new oil pools and 24 gas pools.

with higher rotary rpm, greater wear on the bearings resulted, but due to conditions under which the data was obtained we could not correlate the effect satisfactorily. For short intervals of time, such as these bits were run, the bearing wear was very slight and the results indicated that the cutter teeth were affected primarily.

In the preceding two curves we presented data to show the effect of variation in rotary rpm and weight on the total penetration of the bit in feet. The next two curves, Fig. 8, are presented to show the effect of these variations on the rate of penetration for the life of the bit in feet per hour. The curve on the left plots the rate of penetration for the life of the bit vs. rotary rpm with the weight held constant at 25,000 lb. This curve was prepared by running six bits at rotary speeds varying from 50 to 175 rpm. It is interesting to note that at 50 rpm and 25,000-lb load the overall rate of penetration was approximately 16 ft per hr, whereas at 175 rpm and 25,000-lb load, the overall rate of penetration had increased to 25 ft per hr. Under these conditions, this wide variation in rotary speed increased the rate of penetration only 69 per cent.

The curve on the right was plotted to show the rate of penetration for the life of the bit vs. the load on the bit in thousands of pounds, with the rotary speed held constant at 50 rpm. It will be noted that an increase in the rate of penetration of 700 per cent is indicated between the bit run at 15,000 lb and the one run at 50,000 lb; however, as previously pointed out, the life of the teeth is greatly reduced by the application of more weight. These curves also point to the fact that drilling weight affects the performance of a rock bit more than rotary rpm.

Fig. 9 contains the last two curves and combines the information presented in the preceding six curves into a form that illustrates the optimum rotary rpm and weight for maximum drilling efficiency in a given formation. For this figure a hypothetical case was assumed and data presented in previous curves was applied, to arrive at a time required to drill 100 ft of formation, (in this case granite) taking into account the total life of the bit and the trips necessary to change bits. The curve on the left plots total time in hours to drill 100 feet vs. rotary rpm. This curve was arrived at by running bits at a constant load of 25,000 lb, varying the rotary rpm. It will be noted that under laboratory conditions, very little change is noted in the time required to drill 100 ft of hole by varying the rpm. This means that, as the speed is increased, the reduction in the total life of the bit offsets the increase in rate of penetration. As there is no apparent gain in economy by higher rotary rpm, a low speed was selected to plot the data presented in the curve on the right. This curve plots total time in hours to drill 100 ft vs. load on bit in thousands of pounds.


TOTAL TIME IN HOURS TO DRILL 100 FEET
ROTARY R.P.M.
LOAD ON BIT IN THOUSAND POUNDS
MOST EFFICIENT RANGE OF WEIGHTS TO RUN ON BITS AS TESTED IN LABORATORY TO GIVE MAXIMUM BIT LIFE

(Load constant at 25,000 lb) *(Time required to change bit assumed to be 4 hr)*

(Rotary speed constant at 50 rpm) *(Time required to change bit assumed to be 4 hr)*

FIG. 9. Effect of rotary rpm variations and load variations on drilling efficiency of rock bits as expressed in time to drill 100 ft of hole.

For example, at 15,000 lb and 50 rpm, the total time arrived at for drilling 100 ft was 40 hr. In the ranges of from 20,000 to 26,000 lb, the time required was approximately 32 hr, which is a substantial saving. You will note that loads greater than 26,000 lb indicate a reduction in economy. By the time the weight has been increased to 50,000 lb, the time required to drill 100 ft of hole has increased to 72 hr, which represents an increase in drilling time of approximately 125 per cent. From this curve we see that somewhere in the range of 20,000 to 26,000 lb is the correct weight to apply to the bits, tested in this experiment.

We do not intend to convey the thought that the same figures can be applied directly to field drilling conditions, but we feel that similar weight and rotary rpm combinations can be worked out in the field that will give results similar to those presented.

In closing, we would like to impress upon you that these data apply only to the formation tested and under the laboratory conditions mentioned. These data present a definite pattern for drilling only under these conditions.

It is our opinion that similar curves of definite pattern could be worked out for other formations. Softer formations or more abrasive formations would probably give slightly different characteristics, but the pattern would exist and the optimum weight and rotary rpm would be indicated.

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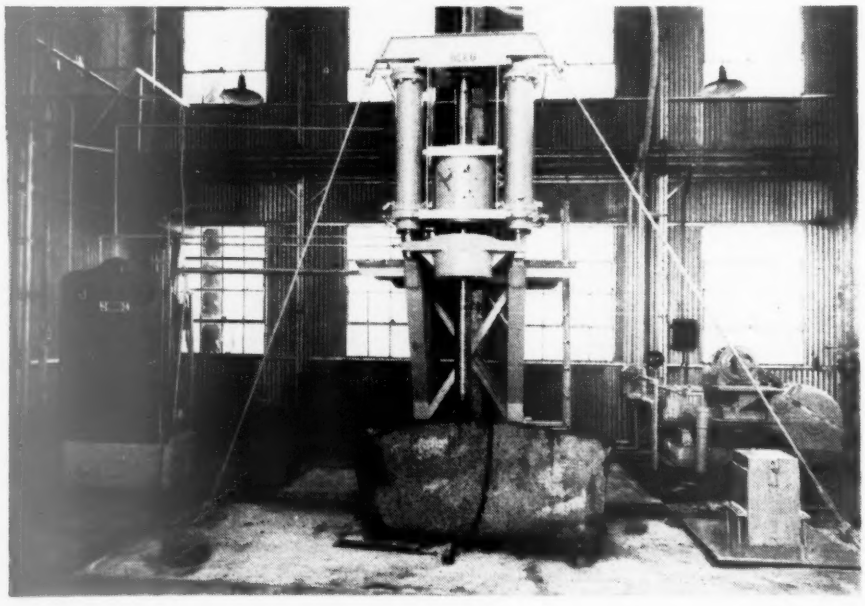
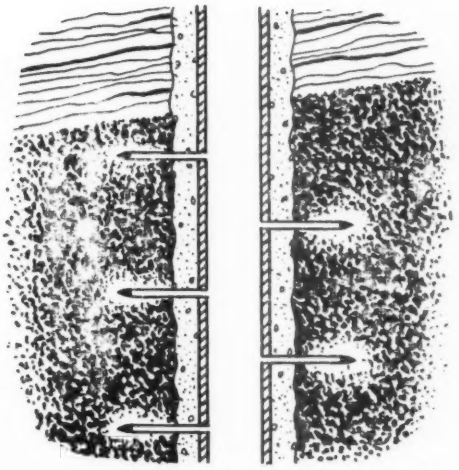
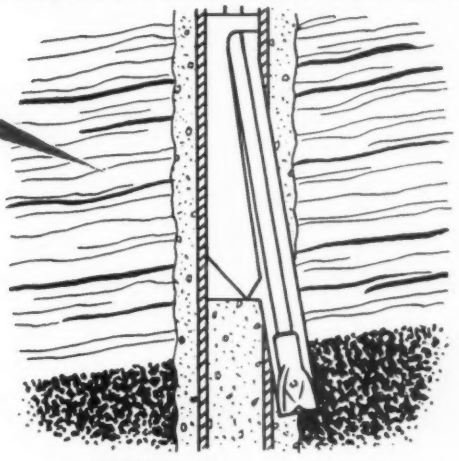
Drilling machine used in collecting data used in this experiment.



BLACK MAGIC
Oil Base Drilling Fluid
INCREASES PRODUCTION 828%



Only 49 B/D on the gas lift, completed with salt water starch mud



455 B/D net oil, flowing, *in the same well* completed with

BLACK MAGIC

RECENTLY A WELL in the Paloma field was completed with a salt water starch mud with a fluid loss of only 0.8 cc. API, and after three series of perforations produced at a disappointingly low rate of 49 B/D net oil on the gas lift. The operator then decided to whipstock out of the casing just above the producing zone and to redrill to the same zone using Black Magic. Upon completion, the well came on production for 455 B/D net oil, flowing through 28/64" choke, *an increase of 828%.*

Recent field experiences prove conclusively that any water (fresh or salt) has disastrous effects on producing sands in any field. Two wells in the Mt. View field were killed with water. The first was producing 1160 B/D at the time. When plugged back to the original zone, only 106 B/D was the best that could be obtained. The second was flowing 784 B/D before being killed. When recompleted, the best production rate here was 264 B/D. That's an example of how water in the producing sands blocks recovery – *sometimes reducing the permeability of sand as much as 60 times.**

Black Magic has a filtrate loss of zero; it cannot and will not water block or mud off the pay section. Black Magic deposits a paper thin cake that readily disintegrates when crude oil displaces it just prior to allowing the well to come on production, thus *assuring the highest return permeability possible.*

With prices of crude steadily rising to new highs, production-wise operators are no longer gambling with "low water loss" muds because they are initially cheaper. If a mud with a fluid loss of only 0.8 cc. can damage a formation to the extent that redrilling is necessary, then the few extra dollars initially invested in Black Magic will pay out in added protection, many times over. Write for "The Paloma Story" describing actual core tests made by a major oil company.

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*API paper 801-20E, March 1944, by W. H. Farrand and W. A. Clark.

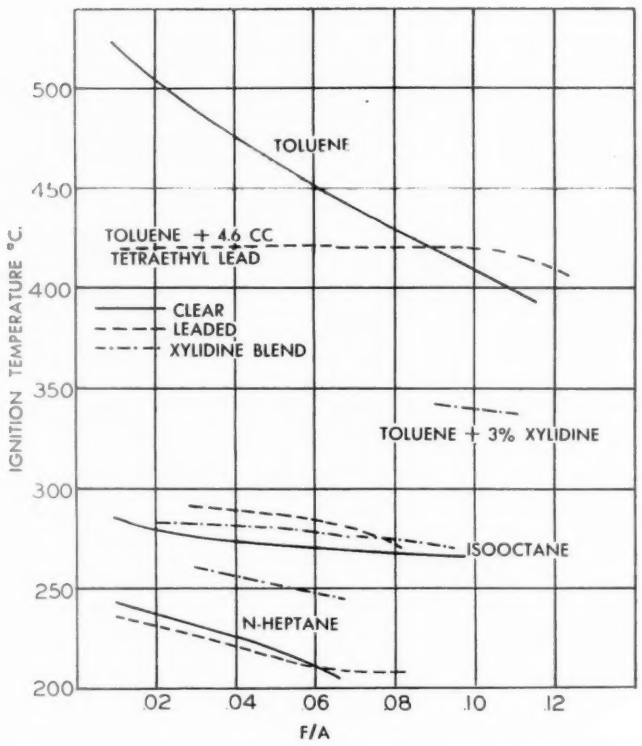

FIG. 1. S.I.T. of clear and doped fuels under pressure.

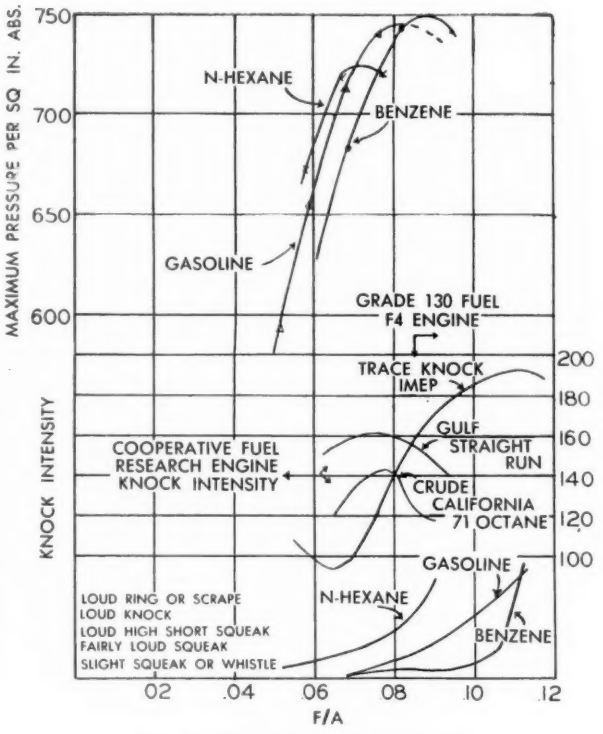

FIG. 2. Pressure measurements on spark ignition of various fuels.

Calculation of knock-free engine power

By PETER J. GAYLOR

SEVERAL articles have been written with the intention of leading to a possible method for anticipating trace-knock engine performance of fuels (if their composition is known), without the need of expensive engine tests, or, if their composition is unknown, by employing certain laboratory data to obtain the necessary basis for calculation. Before going into this subject further, however, some comments are thought to be desirable concerning the previous articles. In Fig. 13 of the first article[1], the curve for clear isooctane is shown with a downward trend in the lean mixture zone. This curve should have been shaped as shown in Fig. 12, or as Fig. 1 of this article. In Fig. 14 the "Trace Knock IMEP" legend on the right refers to the long curve with the reverse bend, as shown in Fig. 2 of this article. In Fig. 15, the third record has some dashes above "60°". In the first space between the dashes, there should have been inserted "t_1", and in the second space "t_2", the borderline between the two being the half-way point of the slope of the explosion curve. The corrected record is shown as Fig. 3 of the present article. The caption for the ordinate in Fig. 18 should be as illustrated in Fig. 4 of this article. In the lowest chart in Fig. 19, the ordinate caption should be as shown in Fig. 5 of this article.

EXCLUSIVE

In the second article[2], Fig. 3 should have for its ordinate "Trace Knock IMEP," as shown in Fig. 6 of the present article. This is of importance, for the latter measurement includes factors other than the knocking property alone, as for example the Btu value of the fuel, thermal efficiency of the fuel, etc. Such considerations are particularly significant in the rich mixture range, as is apparent from the exhaust gas analyses for impure isooctane and benzene (as determined by D'Aleva and co-workers), the graphs for which are illustrated here as Figs. 7 and 8, respectively. As isooctane gives a peak trace knock IMEP at about 8:1 air-fuel ratio, its exhaust gas would contain about 11.2 per cent hydrogen, whereas the exhaust gas of benzene at its peak point (9:1 air-fuel ratio), would show about 4 per cent hydrogen, or about one-third as much. As the specific heat of hydrogen at 1800 C is about 3.704, whereas those for carbon dioxide, carbon monoxide, nitrogen, and water are 0.2645, 0.2651, 0.2659, and 0.5666, respectively, it can be shown readily that the hydrogen produced has a controlling effect in the exhaust sensible heat losses. The heat lost in the exhaust of isooctane is about twice that of benzene, the hydrogen being responsible for about one-fourth of the heat loss in the case of benzene and one-half in the case of isooctane.

Now, to continue with the original intent of the articles, there can be brought to attention an article by Singer[3] wherein he discusses the so-called "Ethyl Blending Chart," and compares it with a chart that he developed for the purpose. He also states that: "The antiknock increase obtainable with lead tetraethyl is not, however, linear with the added concentration; for example, when the

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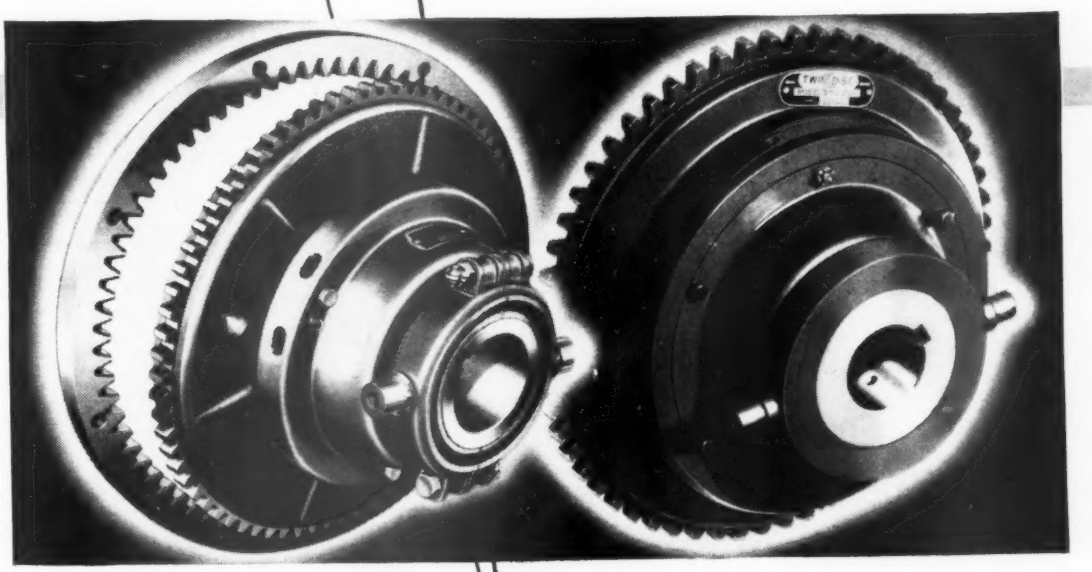

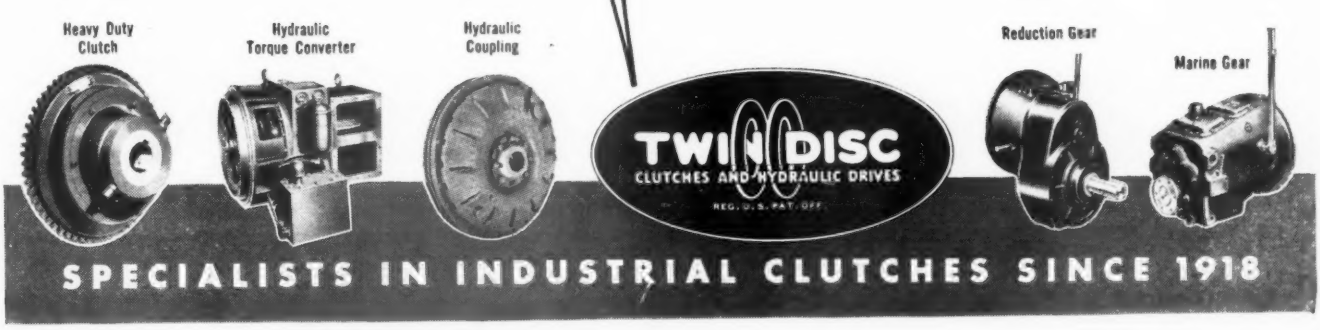

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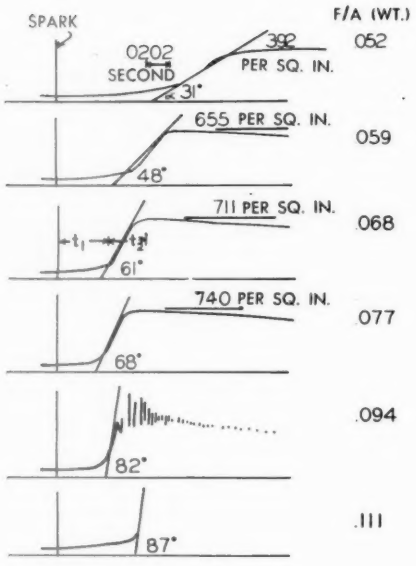


FIG. 3. *Left*—Gasoline-air explosion records at various F/A ratios.

lead content of a gasoline is increased four-fold from 0.25 cc/1. to 1 cc/1., the effect is only doubled." This "square root rule" appears to be applicable when knock alone is considered, and not trace-knock power, which introduces other unrelated factors. Fig. 9 shows the lead response of various pure hydrocarbons on a square-root abscissa chart.

If we assume that this relationship is generally applicable, then, by reference to Fig. 10, we can see that for a given clear octane number the increase in octane number ($\triangle$ ON) due to the addition of a given cc/per gal of TEL would be:

$$\triangle \text{ ON} = \tan \alpha \sqrt{\text{TEL}}$$

and the octane number of the leaded blend (ON_L) would be:

$$ON_L = ON + k \tan \alpha \sqrt{TEL}$$

where ON is the clear octane number, and k is a constant to correct for the difference in distances of the ordinate and abscissa units.

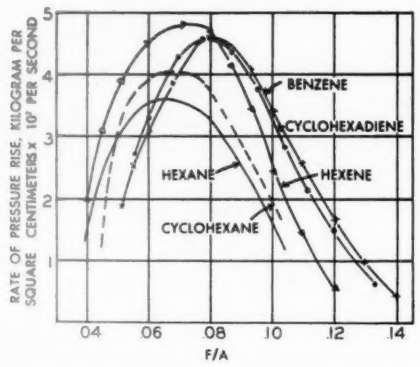
The lead susceptibility can then be expressed as k tan α and, as such, it would be readily convertible into octane number units:

Lead susceptibility = k tan α

As mentioned in the previous article[2], lead susceptibility may be related to other physical properties of the fuel.

It is also known that enriching a charge tends to increase the total heat input and also the power, up to a certain point, after which more heat is lost (through incomplete combustion and sensible heat) than is gained through introduction of additional fuel. This can be illustrated by the following:

FIG. 4. Rate of pressure in explosions of C_6 hydrocarbon.



Exhaust gas analyses from impure iso-octane and benzene.

FIG. 7.

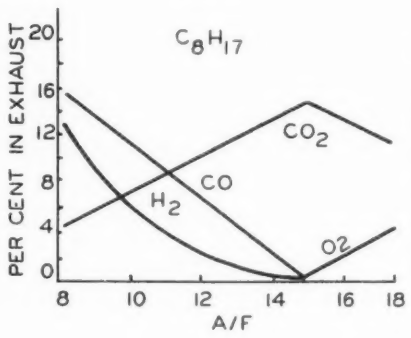


FIG. 8.

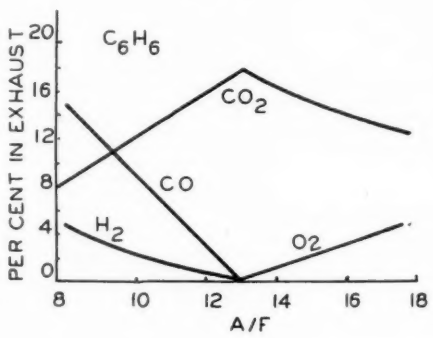


FIG. 5.

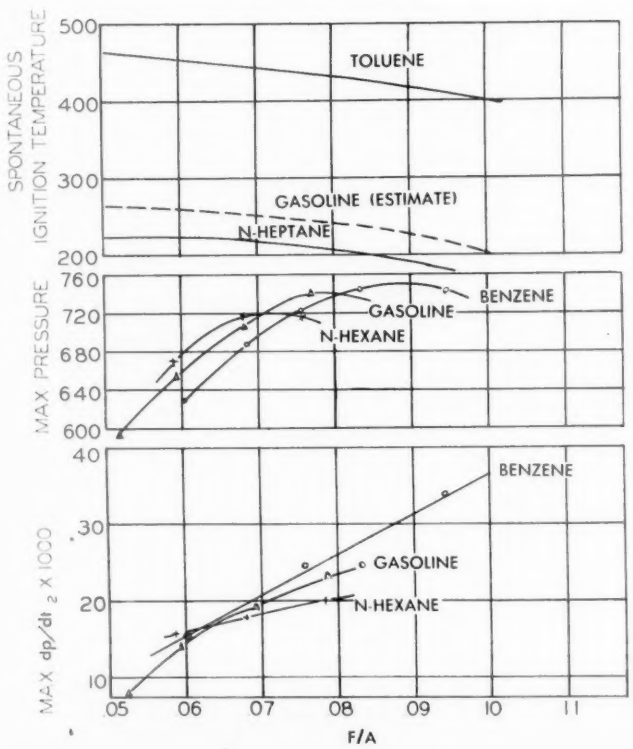
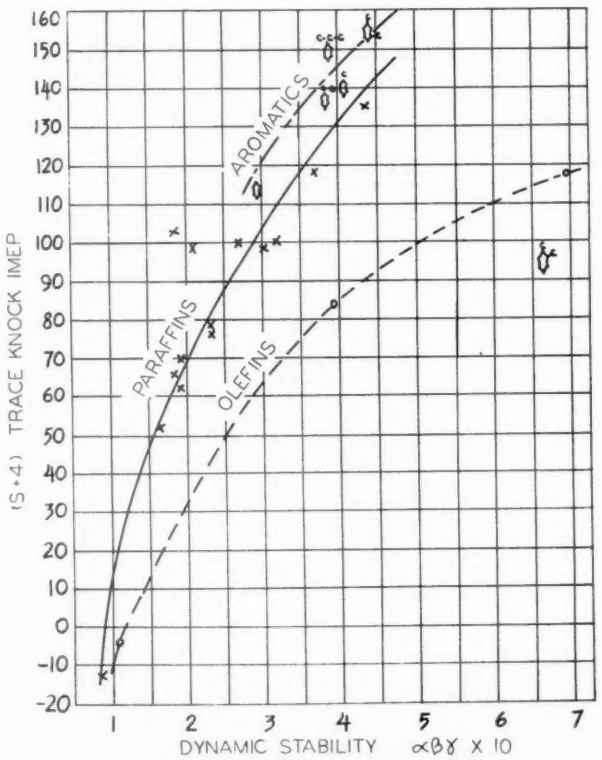


FIG. 6.



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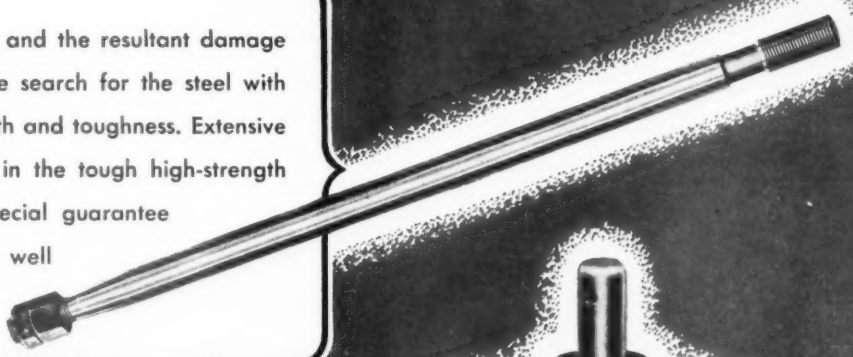

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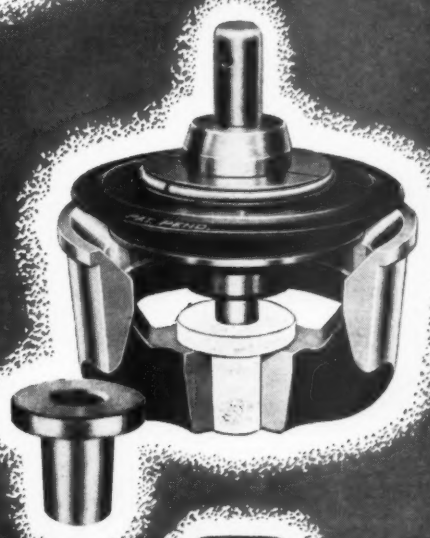

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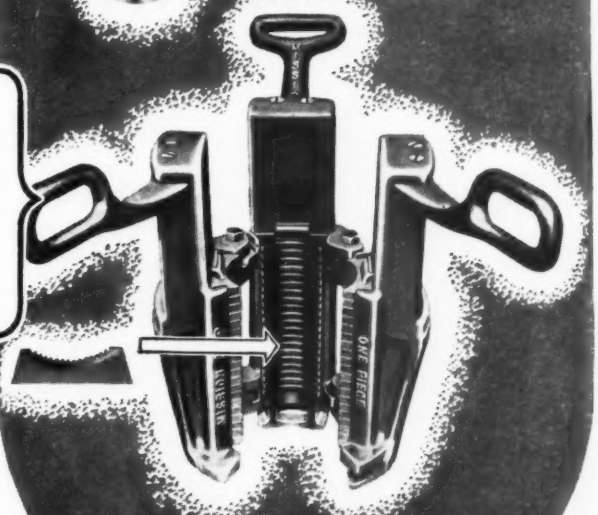

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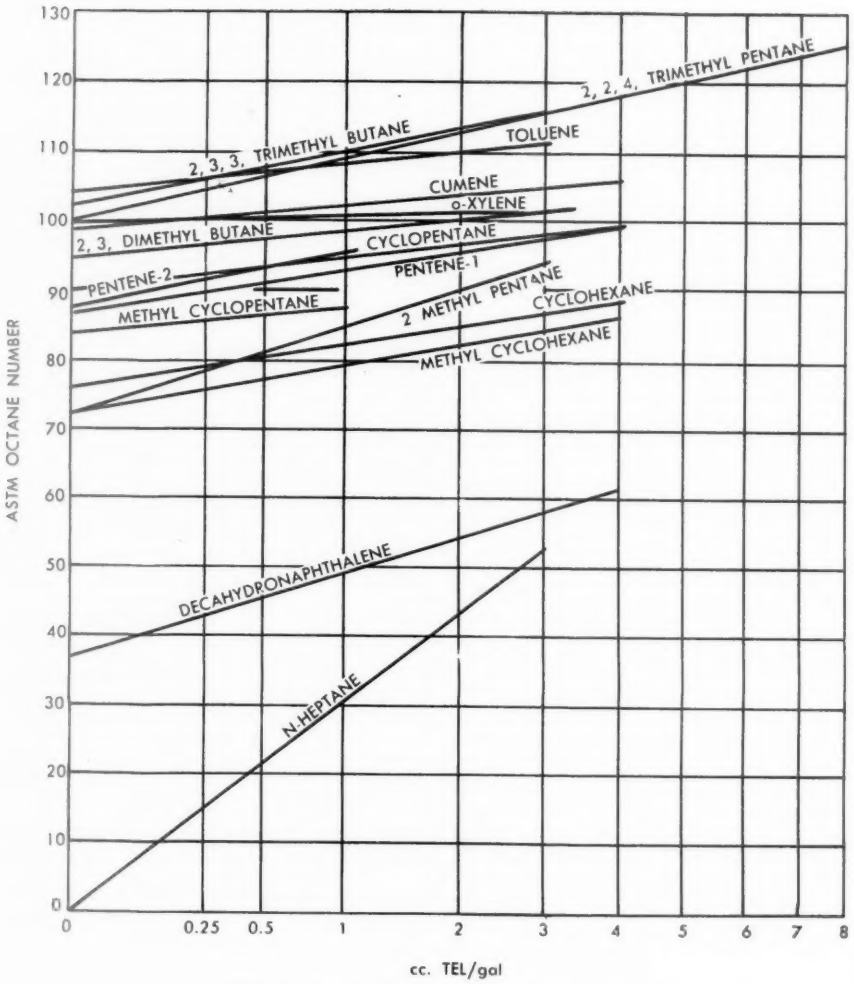


FIG. 9. Lead response of hydrocarbons.

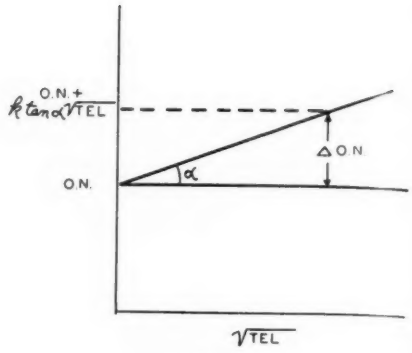


FIG. 10.

Heats of combustion.

Benzene A/F	Benzene F/A	Per cent of theory	Btu/lb fuel	Btu/charge
15:1	0.067	0.88	16,850	15,000
13.2:1	0.076 (theo.)	1.00	17,480	17,480
11:1	0.09	1.18	14,840	17,500
10:1	0.10	1.32	12,000	15,800
Isooctane				
14.7:1	0.066 (theo.)	1.00	19,600	19,400
13.5:1	0.074	1.12	17,200	19,500
12:1	0.087	1.32	15,000	19,800
9:1	0.11	1.67	11,150	18,600

As is apparent from this table, enrichment lowers the Btu per lb of fuel due to formation of CO instead of CO_2, etc., but the Btu per charge increases because of the additional amount of fuel consumed, until a point is reached where heat loss through incomplete combustion cannot be compensated by further addition of fuel.

It has been pointed out already that despite the millions of dollars spent on combustion research, very few reliable data and calculations are available on pure fuels at various fuel-air ratios with respect to heat available for power, etc. One German article[4] lists some data for a few hydrocarbons and, although they do not appear entirely reliable, they will

FIG. 11.

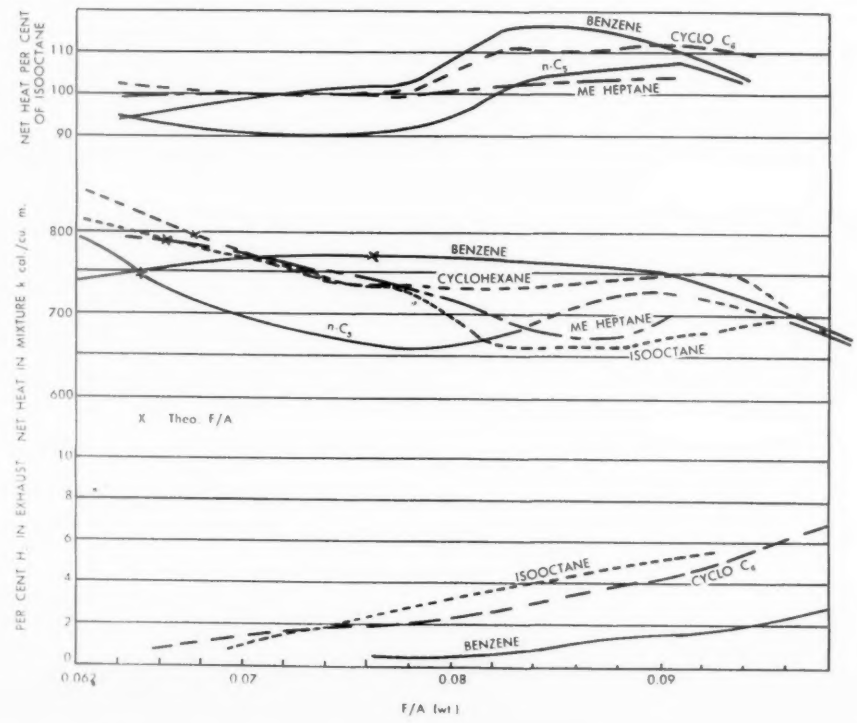
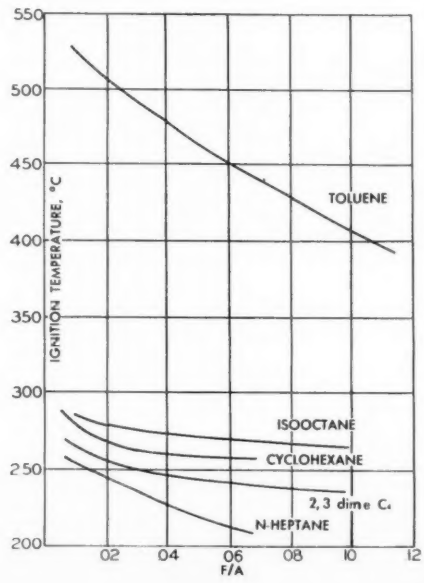


FIG. 12.



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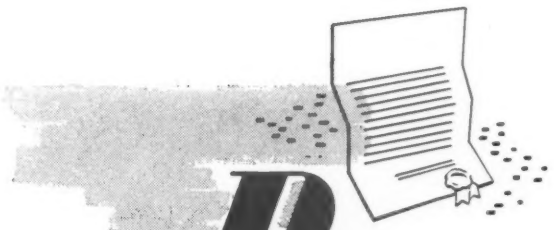

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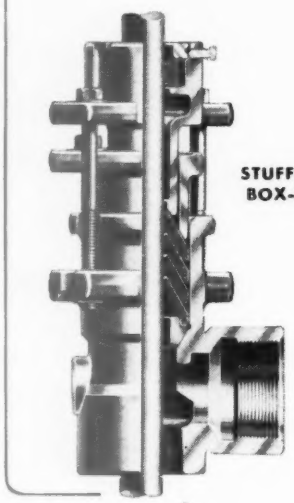

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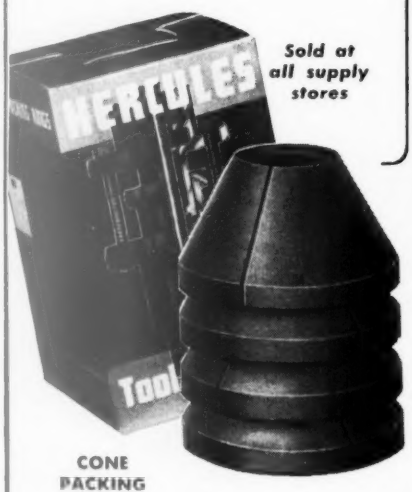

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be used here for lack of better data. These calculations are plotted in Fig. 11 in which the net heat in the mixture is plotted in the middle set of curves, i.e. the heat of combustion less exhaust heat loss, neglecting jacket and other engine losses. These values, compared to that of isooctane at the same F/A ratio, are shown in the upper set of curves, whereas the lower set indicates the percentage of hydrogen in the exhaust, which has been shown to be one of the major heat losses in the rich zone. It can be seen that the relative net heat available for power (H) varies considerably with F/A ratio, as is shown by the following table:

Relative net heat available for power
(Kg cal/cu m mixture)

Fuel	Lean		Theoretical		Rich			
	F/A	H	F/A	H	F/A	H	F/A	H
Isooctane	0.064	795	0.066	780	0.082	665	0.094	695
Cyclohexane	0.064	810	0.0675	790	0.082	735	0.094	745
Benzene	0.064	750	0.076	780	0.082	770	0.094	720

The top set of curves in Fig. 5 indicates the net heat relative to that of isooctane, isooctane being the present standard of comparison. Benzene, for example, gives less heat (93 per cent at 0.064 F/A) in very lean mixtures, but gradually surpasses isooctane and attains a value of about 116 per cent of that of isooctane at about 0.084 F/A, after which it drops, reaching a value of 103 per cent at 0.094 F/A. These calculations, of course, do not take into consideration how much of this power would be available on a practicable basis as a result of knock limitations.

The previous articles have indicated that relative knocking tendencies of fuels under a set of conditions might be correlated from spontaneous ignition and rate of combustion data under such conditions. Such values, together with calculated net heat data, may be a means of eventually evaluating trace-knock power of fuels without the necessity of engine tests.

References.

1. Gaylor, *The Petroleum Engineer*, December, 1946, p. 790.
2. Gaylor, *Ibid*, March, 1947, p. 72.
3. Singer *Oel u. Kohle* October, 1941, p. 804.
4. Wawrziniok, *Automobil Tech. Zeit. 12*, p. 236 (1932).

★ ★ ★

P 094.99

How to measure for a gasket

By W. F. SCHAPHORST

CONTRARY to the common belief, it is not necessary to take a flange apart in order to measure for a gasket. Measurements may be accurately made from the outside as indicated by the accompanying sketch. By means of a pair of calipers take the distance from the inside of one bolt diametrically opposite. This gives the exact outside diameter of the gasket.

For the inside diameter, either measure the inside diameter of the pipe, as shown, or consult a handbook giving the inside and outside diameters of standard pipe. The table will give the exact inside diameter. The inside diameter of the gasket should be the same as the inside diameter of the pipe so that no water or gas pockets will be formed.

The above method is better and quicker than the one usually recommended, namely, to measure from center to center of the bolts and then subtract the diameter of the bolt. No error can be made if the above method is followed.

When ordering a gasket it is usually best to give the exact dimensions, particularly the exact distance between bolts so that the manufacturer can supply a gasket of the correct size. He will probably deduct 1/32 or 1/16 of an inch. It is better to leave the deductions to the manufacturer than to do it oneself.

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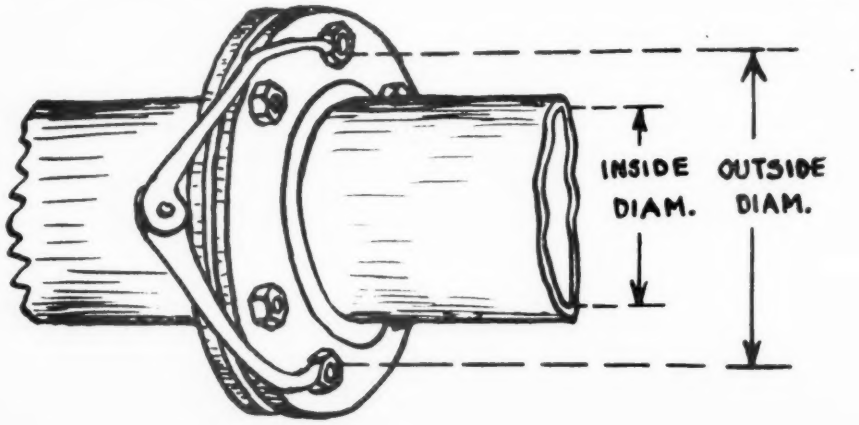

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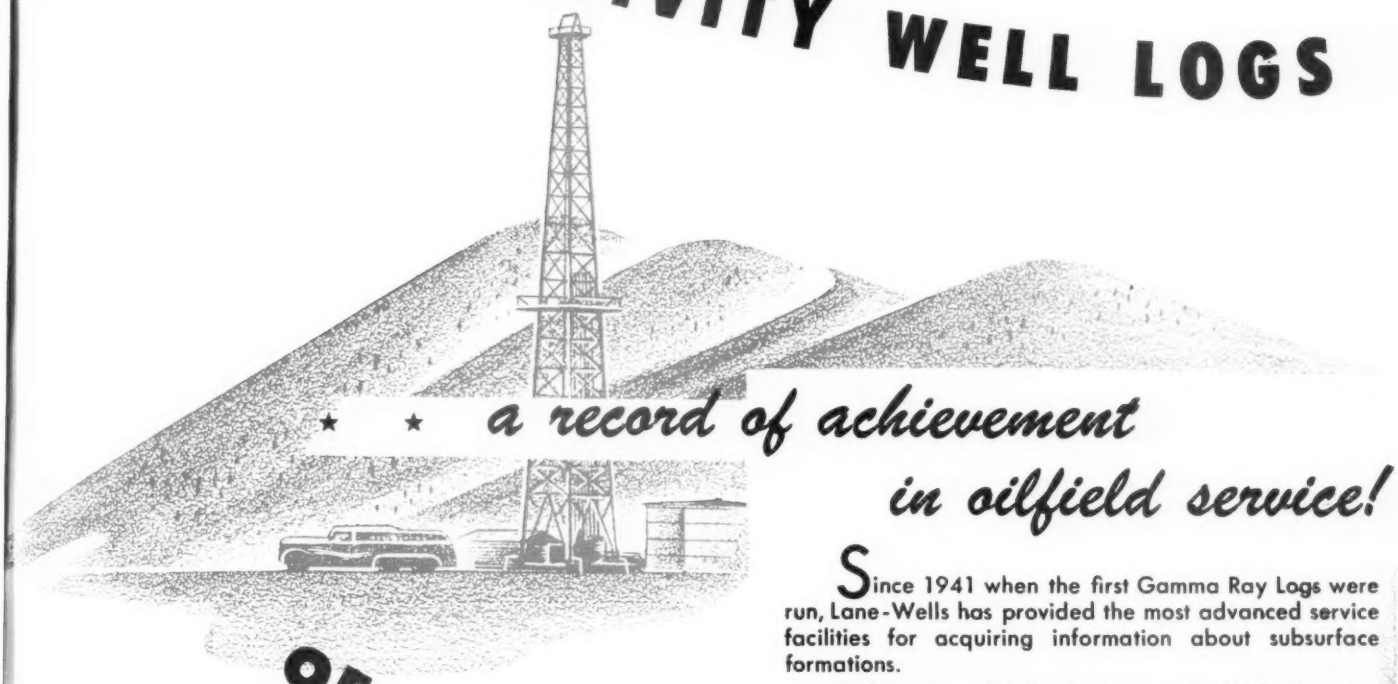

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Crude stabilizers in Venezuela fields

By J. G. COULTRUP, *Chief Process Engineer*, Tellespen Construction Company

EXCLUSIVE

WITHIN the last two years at least two of the major producing companies in Venezuela have begun the construction and/or operation of crude oil processing plants in the producing fields of Eastern Venezuela. These plants are called crude stabilizers, because stabilizing the crude oil is a portion of their function. Venezuelan producers and other major operators are now actively studying other fields for the installation of similar equipment.

This article will be confined to the discussion of the three plants in operation or under construction, that is, Creole Petroleum Corporation's plants at Jusepin and Mulata and Consolidada's plant at Santa Barbara. These three plants all have pressure maintenance as one of their major functions. Two of the plants return major portions of the produced gas to the reservoir and the third returns a small portion (10 to 15 per cent) on a test basis. All plants treat the returned gas to recover the gasoline fraction before injection. All three plants depropanize and dehydrate crude oil, whereas two plants are equipped simultaneously to dehydrate and desalt the oil.

J. G. Coultrup

In order to understand the reasons for the selection of equipment and processes to be described it is necessary to list some of the field conditions.

The four fields, Jusepin, Santa Barbara, Muri, and Mulata, are considered as one field, for they all produce from the same general formation and the dividing lines are based on concession lines.

These fields are in the State of Monogas in Eastern Venezuela and lie about 100 km southwest of Caripito and 160 km southeast of Puerto La Cruz. (Figures given are pipe line and road distances.) They are connected to both of these shipping terminals by pipe line, but, the major crude movement is through Puerto La Cruz because of the harbor facilities and ease of entry for ships.

The Monogas fields are generally anticlinal in structure with traps being formed by a combination of stratigraphy and block faulting. This, together with multiple producing zones, forms a large number of individual reservoirs. No gas caps of any importance have been found and there has been no evidence of water drive in any of the reservoirs.

The oil is about 33 deg API and the composition of the reservoir fluid is essentially the same for all reservoirs. The Jusepin field was discovered in 1938 and commercial production began late in 1939. The other fields (extensions) were discovered in 1941. Early in the life of the Jusepin field it was evident that the producing mechanism would be dissolved gas drive, and studies were begun in 1940 to determine the economics of pressure maintenance. In conjunction with these studies the economics of a natural gasoline plant for this field were studied.

This report, completed in 1941, after many revisions because of the constant changing geological picture with development drilling, recommended a pressure maintenance project and a gasoline plant. Before it could be started, however, the war, with its attendant short-

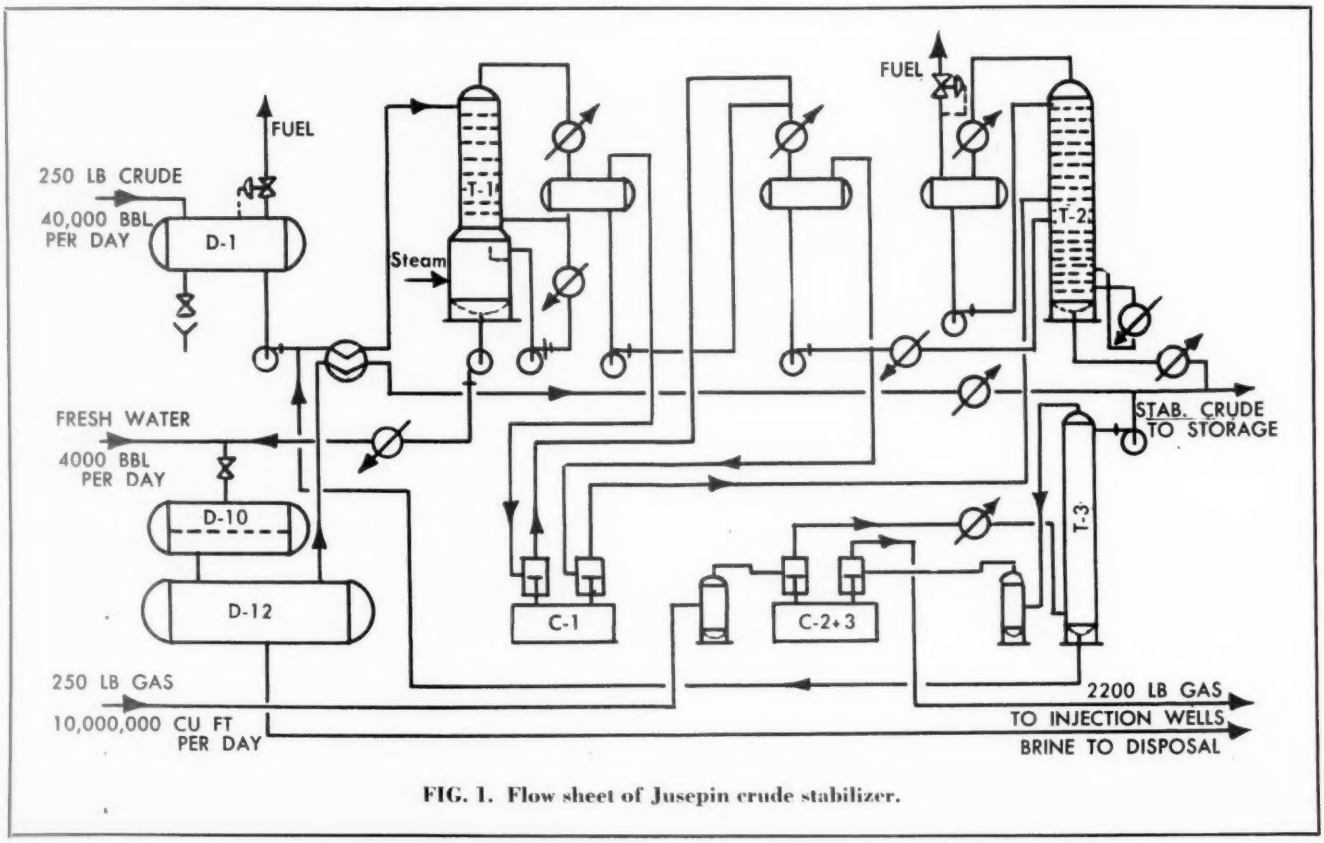

FIG. 1. Flow sheet of Jusepin crude stabilizer.

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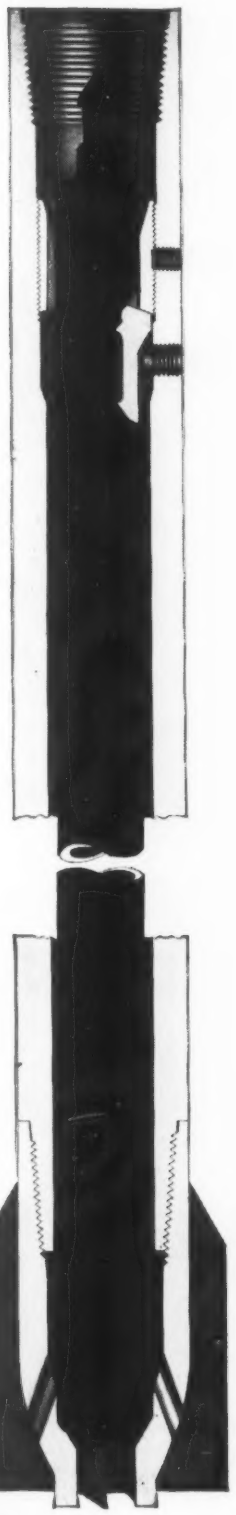

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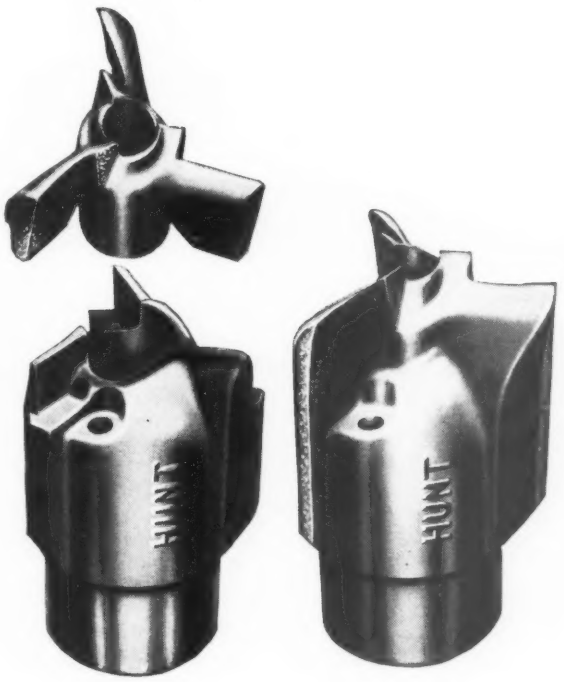

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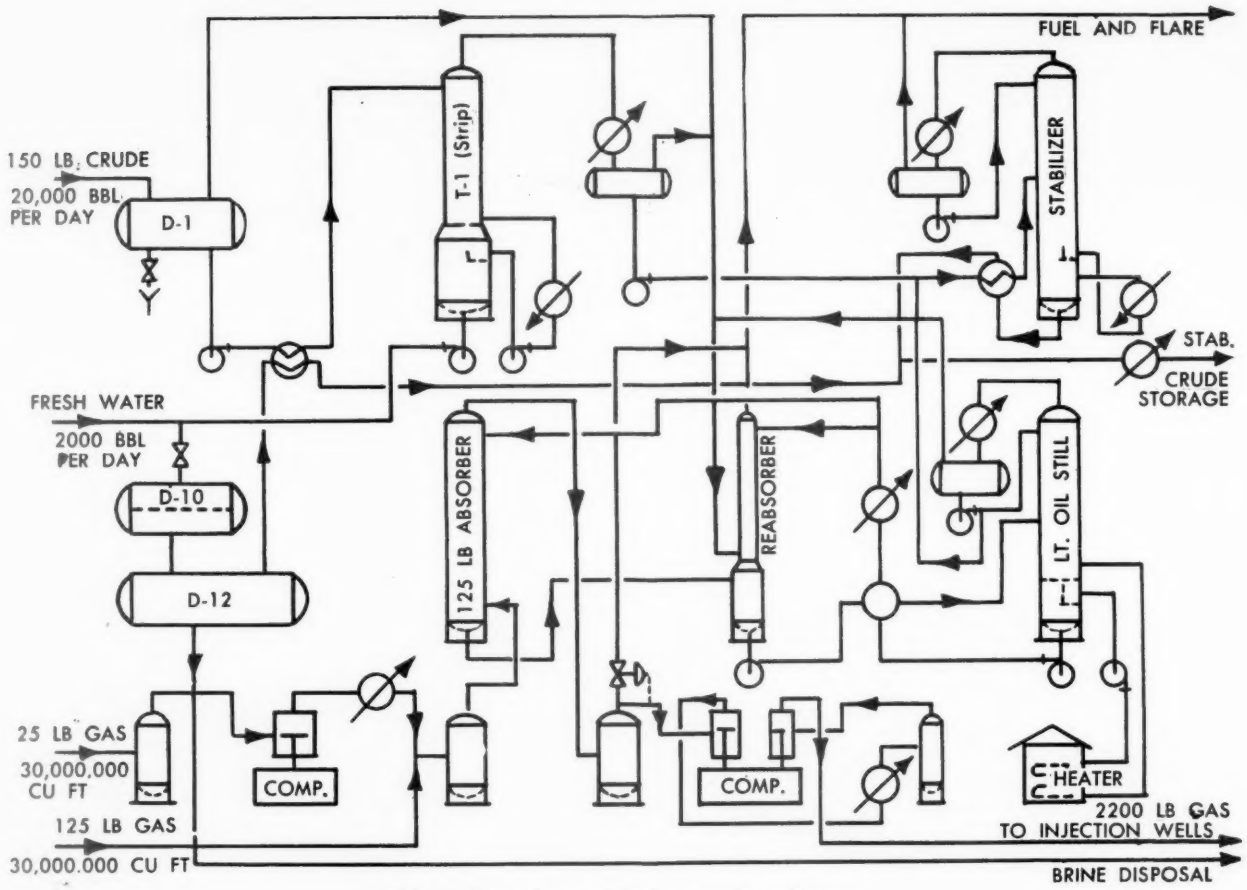

FIG. 2. Flow sheet of Mulata crude stabilizer.

ages of all kinds, forced temporary abandonment of the project. This report is not important except in its effect on the subsequent development of the field and its influence on the final design thinking.

In the absorption plant studies of the 1941 report, the following were controlling factors:

1. There is a very small local market for propane (LPG), which is concentrated generally in Central Venezuela. This market was being supplied in bottles from refineries in the West Indies where an excess of propane existed. As there were no railroads, or all-weather roads, connecting this market with the oil fields in Eastern Venezuela, transportation of LPG would be by pipe line to the shipping terminal and by water to the market. This method could not compete with the low transportation cost from the West Indies, especially in view of the limited market. The same could be said for liquefied butane except that there was no established market for this product in Venezuela.

2. A portion, at least, of the natural gasoline produced could be used for blending in the Caripito Refinery, then under construction and in which it was planned to run 40,000 bbl per day of Quiriquire crude (API gravity 19 deg). Any excess over refinery requirements could be blended with Quiriquire crude for shipment to the West Indies. This crude was ideal for this purpose, for it contained a very low gasoline content.

3. There was no market for natural gas outside the company's own installations.

With the above factors in mind it is clear that the only economic justification for a gasoline plant had to be based on the net value of total products, including crude oil, that could be delivered either to the refinery at Caripito or to one of those in the West Indies. An integrated producing and refining operation was assumed. Under these conditions the value of the products from an absorption plant would be only a small portion of the crude oil value. It was necessary, therefore, to establish the value of the crude oil that could be obtained at the refinery under optimum operating conditions but without an absorption plant.

With wellhead pressure between 700 and 1200 psi available at all times in the field, an extensive survey was conducted to determine the most economic one, two, or three-stage separator system based on net value of the crude at a refinery in the West Indies. These values were calculated on the basis that propane and lighter delivered in the crude had no value. Butanes were assigned a nominal value and pentanes and heavier calculated on the basis of crude oil price plus gravity differential. This survey developed that the economic optimum for this particular field was a two-stage separator system with the first stage at 250 to 350 psi and the second stage at 40 psi. (Series 30 fittings on first stage.

Among the other points of interest developed by this survey were the following:

1. The normal gauging and testing methods were not sufficiently accurate to detect evaporation and filling losses in lease and pipe line tankage. A method was developed for estimating both the volume and composition of these losses using measured temperatures of the oil in storage and vapor pressures determined by air saturation method on samples withdrawn under pressure from transfer lines.

2. The vapor pressure of the oil in the various lease and storage tanks remained essentially constant for each tank under varying conditions of separator pressure, so long as the filling and emptying cycle of each tank and the temperature cycle remained essentially constant. This factor, which would be expected since the change in vapor pressure is primarily a function of the quantity of air present in the tank. allowed the evaporation losses to be interpolated and extrapolated by calculation, thus reducing the amount of field testing and providing data beyond the range for which equipment was available for actual test. The tests, carried as they were to the final destination, were complete enough to show that for ordinary operating conditions each additional tank in the system through which the crude passes represents an additional loss of valuable constituents of the crude and that this loss is appreciable in cone roof tanks until the crude vapor pressure drops below about 8 psi

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measured at atmospheric temperature.

These studies showed that an absorption plant in conjunction with a pressure maintenance project would be economically justified (based on 1939-1940 prices for absorption plant equipment) and that the most economic separator would be about 75 psi, with gathering and recompression of tank vent gases and absorption at an intermediate pressure of about 800 psi.

When the plant installation was temporarily abandoned because of war, the operator of this field adopted the alternate recommendation and installed two-stage separation in the field. As the field developed, the following system was evolved:

Field manifolds were erected throughout the field, each manifold being connected to one large and to one small high pressure separator. From 8 to 30 wells were connected by flow lines to these manifolds. The oil from these separators, which were operated at 250 psig, was carried by pipe line to a central point where second stage separation and gauging took place. From the large stock separators at each manifold the oil went to large second stage separators operating at 40 psi and thence to pipe line storage in 55,000 bbl cone roof tanks. The oil from the smaller gauging separators flowed through separate lines to a battery of small second stage separators at the central location and thence to a battery of 1000-bbl gauging tanks. The separate lines and tanks for gauging were required because the operator could not obtain accurate liquid meters, however, these are now available and are being installed.

This system resulted in a considerable saving of light fractions as well as a reduction in the amount of tankage, pumps, separators, etc., required to develop the field and a reduction in the overall quantity of new steel required. (The small lines from the test traps to the central point were usually made of salvaged pipe.) It also resulted in the reduction of one tank in the system through which the oil passed with the attendant reduction in evaporation losses.

The Mulata field (extension), discovered in 1941 by the same operator, was developed along these same lines.

Late in 1944, the general shortage of light ends caused the operator to pull out and dust off the plans for a gasoline plant in the Jusepin field. The situation on economics had, however, changed considerably in the interim as follows:

1. The field had already been developed on a two-stage separator basis and this had been done very economically. A change to lower separator pressures at the manifolds would require a large investment in tanks, pumps, power, etc.

2. Present separator pressures could be maintained on most of the wells for an additional five to seven years even without pressure maintenance.

3. The Caripito Refinery, in order to meet volatility requirements, was running a mixture of Quiriquire and Jusepin crude. This allowed it to run at 175 per cent of design capacity, producing both an additional volume of specification gasoline and an increased volume of Navy Special fuel oil. The use of any large quantity of natural gasoline would have reduced the overall throughput and the production of Navy Special.

4. New exploration and development had been in general all to the west of Jusepin and had thus shifted the producing center away from Caripito. The world tanker shortage also had forced the development of Puerto La Cruz as a pipe line and loading terminal because of the reduced tanker turn-around time for this port as compared to Caripito. These factors did not make the Caripito Refinery a good risk as a long term customer for plant products.

5. The cost of natural gasoline plant equipment, installed, had increased at a greater rate than the price of the products during the interim.

6. The field has a total of 275 wells on 17,000 proved acres, producing approximately 50,000 bbl daily at an average gas-oil ratio of 1000 cu ft of gas per bbl of oil.

A recheck of economics of a gasoline plant by the engineering staff, in view of the above changes in conditions, revealed that despite the increase in volume of gas to be handled (approximately 50,000,000 cu ft as against 20,000,000 cu ft in the 1941 studies) the project did not present too attractive an economic picture when compared on a basis of increased recovery with gasoline plant vs. present recovery with two-stage separation.

One of the important factors in this economic picture was the added cost of converting the oil gathering system for low pressure operation. The gas, if separated at 250 psi, was not rich enough to justify recovery equipment.

In studying various alternative processing methods the loss in valuable light hydrocarbon from the oil, between the 250-psi separator and the port was investigated. It was found that, if the 250-psi separator liquid was depropanized by fractionation, the remaining liquid would have a very low pressure and could be transported without losses to the port, and that there would be a substantial gain both in volume and gravity of the crude delivered. This net gain in value of products delivered to the port justified a reasonably large investment in fractionation equipment to effect this saving. The design of the Jusepin plant was, therefore, based on these factors, for it would require no change in the oil gathering system.

Pressure maintenance on a test basis was added while the plant was still in the design stage and compressors were installed to inject 10,000,000 cu ft of gas a day.

During the period while the plant was under consideration, or, in the early design stage, many of the wells began producing slight amounts of salt water (of connate origin). Accordingly, an economic study was undertaken to determine the effect of the special crude oil gathering system on treating costs. A number of methods for segregating and treating the wet oil were investi-

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gated as well as several methods and processes for treating the entire oil stream. It was recognized that any segregation method would be of a temporary nature, for all wells would begin to produce water in small quantities when the reservoir reached a certain stage of depletion in the area of each well. The time when the wells would begin to produce water could be predicted from past performance history of wells in other parts of the field and from pressure decline data. It appeared that a single unit large enough to dehydrate the entire crude stream would be more economical than a number of small units installed at various times as needed. A pressure dehydration system was required in order to minimize evaporation losses (and was economically justified).

By "tying in" the dehydration system with the crude stabilization (depropanizing) the dehydration could be carried out at somewhat higher temperatures than those normally employed, by utilization of the same heat exchange equipment, resulting in a reduction or elimination of the chemical requirement. At these higher temperatures desalting could be combined with dehydration economically and, although there was no premium offered for low salt content, desalting would make this crude more desirable to European refiners who did not have desalting equipment installed. It was anticipated that desalting would make this particular crude more easily marketed during the anticipated postwar period of overproduction. The additional cost for desalting over dehydration alone was negligible and the overall cost of dehydration and desalting was estimated at about 0.5 cent a bbl. This compares favorably with dehydration costs for similar crudes both in Venezuela and in the United States.

The above discussion of factors and events leading to the final selection of processes and equipment for the Jusepin plant has been prepared by the writer in order to answer a few of the "why didn't they" questions in advance and to indicate the mass of data that was accumulated and the number of detailed analyses and economic studies that were carried out in arriving at this final design.

● **The Jusepin plant.** A simplified flow diagram of the Jusepin plant is shown in Fig. 1. Crude oil from the field separators enters the plant and flows into crude surge drum (D-1). A small amount of gas is vented at this point and any free water is automatically drawn off. The crude is picked up by a pump and sent through a bank of heat exchangers where it is exchanged with the hot oil leaving the plant. It then flows into the stripper tower (T-1) near the top. This tower operates at a pressure of 20 psig and a bottom temperature of 235 F, which is maintained by a steam reboiler, and steam is used as the stripping medium. Splash baffles rather than bubble trays are used in this tower to prevent the accumulation of any sand or sediment contained in the oil. Essentially, all the porpane and lighter is taken overhead from this tower together with some of the heavier components.

The oil is picked up by a pump from the bottom of this tower and passes through steam preheaters to the dehydration-desalting section. The dehydration section operates at a temperature of 300 F and pressure is controlled by a back pressure valve at approximately 200 psig. This is sufficient to insure that no gas is flashed.

The crude is mixed with fresh water (6 to 10 per cent by volume on charge) and emulsified by passing through a constriction in the line (globe valve); it then passed to a coalescer drum that contains silica sand supported on a gravel bed. It then passed to a settling drum where the salt water is drawn off and sent to a disposal system. The dry stripped crude is exchanged against incoming crude and cooled. A portion of this stream is used as an absorption medium in tower (T-3). The remainder is blended with the bottom products of the stabilizer (T-2) and sent to storage.

The overhead from the stripper (T-1) is all fed to the stabilizer (T-2); the condensible portion being pumped and the gases compressed through two stages. T-2 operates at 350 psig and the bottom temperature is controlled to produce the desired vapor pressure stabilized crude at the plant outlet. Over-

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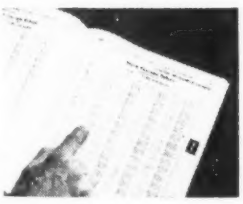

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head from this tower is partially condensed for reflux, the remainder going to plant fuel.

Approximately 10,000,000 cu ft of gas from nearby manifolds enters the plant at 250 psig and is compressed through two stages to 2200 psig for injection.

A small amount of butane and pentane is recovered by absorption of this gas with stripped crude in absorber (T-3). This tower operates at interstage pressure of 775 psig. The rich crude from this tower returns to the exchanger bank ahead of the stripper (T-1).

The Santa Barbara and Muri fields, discovered in 1941, were developed by another operator along more conventional lines so far as surface equipment is concerned. A smaller reservoir plus closer well spacing resulted in a much more rapid pressure decline in this area so that by 1945 artificial lift and secondary recovery methods were being studied by the operator. These studies resulted in a decision to institute a pressure maintenance or gas drive program. Accordingly, a repressuring plant was installed to inject approximately 20,000,000 cu ft of gas (about 70 per cent of the gas produced), into the reservoir. As the plant suction and field separator pressures were relatively low (10 psig at plant suction) the gas was rich enough to justify an absorption plant.

The absorption plant installed was a typical high pressure plant designed for relatively high propane recovery. It consists of a high pressure absorber operating at about 700 psig, a reabsorber, a two-stage lean oil still (high and low pressure), and a fractionating section consisting of three columns and designed with sufficient flexibility to allow production of almost any grade of natural gasoline and two LPG products (either propane and butane, or isobutane and normal butane). Provisions are included for dehydrating the residue gas.

Unusual features of the plant included a still running on crude oil and producing motor fuel, diesel fuel, and absorption oil for use in the company's field operations and the plant. Also, included is a central dehydration plant for the crude, operating inside the plant limits. The crude is dehydrated at approximately 140 F. A vacuum is maintained on the dehydration system by compressors and the gas flashed at this point, containing essentially all the propane and lighter from the crude, is sent to the absorption plant.

The crude oil and natural gasoline are stored separately in the field but are blended for transport to the port via pipe line. This plant went on stream in September, 1946.

● **The Mulata plant.** The depletion rate for the Mulata field was somewhat more rapid than for the Jusepin field but not so rapid as that of the Santa Barbara area. The same operator operates both the Mulata and Jusepin fields, therefore, the plant design for this field was influenced by the Jusepin plant design; however, the more rapid decline of pressure in this field made the installation of full scale pressure maintenance desirable. The field had been developed along the same lines as the Jusepin field as far as surface equipment was concerned, i.e., manifolds with high pressure separators and a central second-stage separation and storage point, however, extrapolation of the decline curves showed that 250-psi separation could not be maintained for any appreciable period of time.

Investigation carried out in connection with the Jusepin plant studies had revealed that changing the crude gathering system would be very expensive and that the crude could be gathered, dehydrated, and desalted at a central plant at high temperatures and pressures, and that this could be done economically both from a standpoint of cost per barrel and for maximum retention of light ends.

Extrapolation of pressure decline data revealed that approximately 50 per cent of the gas could be separated from the oil at a pressure of 150 psig, and the remainder would be produced from weak wells by natural flow or artificial lift (probably pump). It was considered economically possible to produce these weak wells against a separator pressure of 40 psig. A volumetric displacement pump (blow case) operating on gas from the 150-psi separator could be used to force the low pressure liquid into the oil gathering lines.

The detailed study revealed that it would be economical to process the gas in this instance and that, after the crude had been depropanized, it could hold all the pentanes and heavier from the

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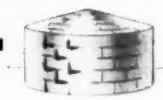

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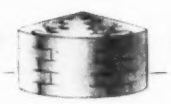

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gas plus about 65 per cent of the butanes without exceeding the vapor pressure limitations set by evaporization losses and liminations of floating roof tankage. The study also showed that all the gas from the field could be economically gathered and processed and that duplicate gathering systems for 150-psig and 40-psig gas would be cheaper than a single gathering system at the lower pressure.

As a result of these studies, the Mulata plant was designed to process 20,000 bbl of crude oil a day, the processing to include depropanizing, dehydrating, and desalting, and to process 60,000,000 cu ft of gas a day, recovering approximately 65 per cent of butanes and all the heavier components, and to supply 21,000,000 cu ft of high pressure gas a day for pressure maintenance operations. Fig. 2 shows a flow diagram of the plant on which construction will begin in December.

The crude oil enters the plant at crude surge drum (D-1) where any free water is drawn off and gases flashed to the reabsorber. The oil then passes through a bank of exchangers to the crude stripper tower. Here the crude is steam stripped to remove all propane and lighter at a pressure of 75 psig. A steamheated reboiler maintains the bottom temperature of 300 F. The stripped crude is withdrawn from the bottom of this tower and pumped without cooling to the dehydration desalting section. This equipment is a single pass electric desalting system using a 28-ft sphere. Dry desalted crude is exchanged with incoming crude from the surge drum (D-1) and blended with the depropanized light products, then sent through coolers to storage.

The overhead from the stripper is cooled and partially condensed. The uncondensible gases go to the reabsorber and the condensate direct to the stabilizer (depropanizer).

The gas enters the plant in two streams, one at a pressure of 25 psig, the other at 125 psig. Each of these streams carries approximately 30,000,000 cu ft of gas a day. Compressors boost the 25-psi. gas to 125 psi and are set up to handle 30,000,000 cu ft.

The main absorber operates at 125 psig and handles 60,000,000 cu ft a day of wet gas. Approximately 21,000,000 cu ft of dry gas is compressed through two stages to 2200 psig, for injection into the reservoir. The remainder operates a turbine and is then released to flare. This low absorption pressure (as compared with modern plants) was found to be economical for the low butane recovery factor desired; also, in the event that a market develops for LPG in the area, it would be cheaper to raise the absorption pressure than to increase the oil circulation rate after the plant had been installed.

Rich oil from the main absorber is flashed in the reabsorber at 65 psig and then goes to the absorption oil still operating at 90 psig. Uncondensible gases from the still overhead are recycled to the reabsorber and the liquid goes to the stabilizer (depropanizer). The bottom product of the stabilizer is blended with the stripped crude enroute to storage while the overhead goes to plant fuel. An absorption oil clean-up still is provided with sufficient capacity to cut lean oil make-up from crude oil either as a continuous or intermittent operation. No storage for products is required because the only product is stabilized crude, which goes to floating roof pipeline storage. ★★★

New Zealand oil exploration discouraging

OIL is not easily accessible in New Zealand and for some time now no effort has been made to bring the island into the best of oil-producing countries.

In a report recently received by New Zealand Oil Exploration Company, Ltd., Wellington, was the following information:

"So far as the New Zealand Oil Exploration Company Limited was concerned, extensive geological work was commenced in New Zealand in 1938 in an endeavor to ascertain whether oil was present in payable quantities. The Dominion was divided into various territories and this company took up licenses giving them the right to exploratory work in Gisborne, Hawke's Bay, Taranaki, and Westland.

"A staff of seven geologists and two surveyors was brought to New Zealand and a geological surface investigation and topographical survey was made of Gisborne, Hawke's Bay, Taranaki, and Westland during 1938 and 1940. At the same time paleontological work was carried out by a small staff in Wellington.

"At the end of 1940 it was decided to concentrate on Westland and structural drilling was undertaken in this district from 1940 to 1943. There were small indications of oil in this area and shallow production at Kotuku had been worked many years previously.

"In May, 1943 an exploratory well was drilled by the company in Westland approximately 12 miles from Hokitika. The unit was powered by Waukesha diesel engines and although the equipment was capable of drilling to 11,000 ft, the hole was abandoned at 2800 ft after the usual core and sidewall samples had been taken and tests run with a Schlumberger electric log.

"On the completion of this well, it was decided to abandon further exploratory work in New Zealand for the time being and although a well was drilled in Westland by another operator after July 1943, this also proved dry and by the end of 1943 all operations in New Zealand ceased. Since that date there have been no further developments in this Dominion." ★★★

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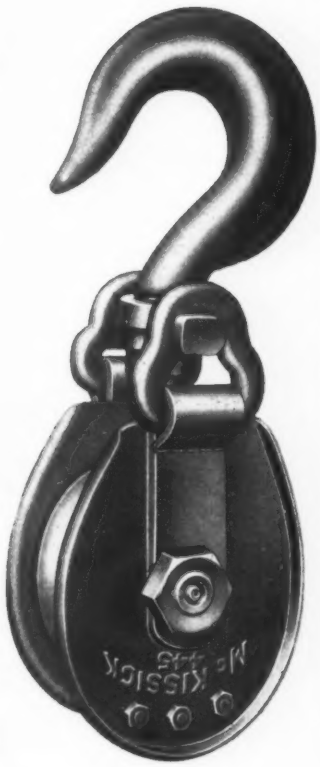

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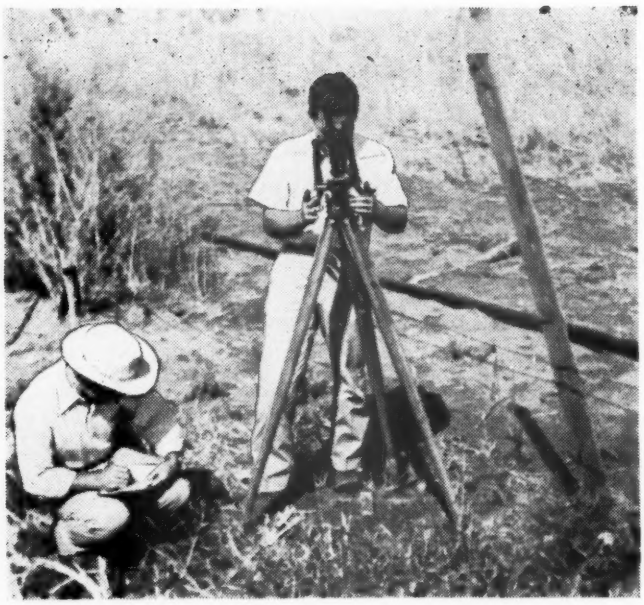


It is the first duty of the instrumentman to be ready at all times to give "line" to the head chainman when required. He must learn to dovetail his other duties into the small intervals of time when the chaining is interrupted.

Pipe line surveys

By PEYTON BRYAN

Division Engineer, Humble Pipe Line Company

EXCEPT for minor details there is little difference between a field survey made for the location of a pipe line and the preliminary route surveys made for highways or railroads.

EXCLUSIVE

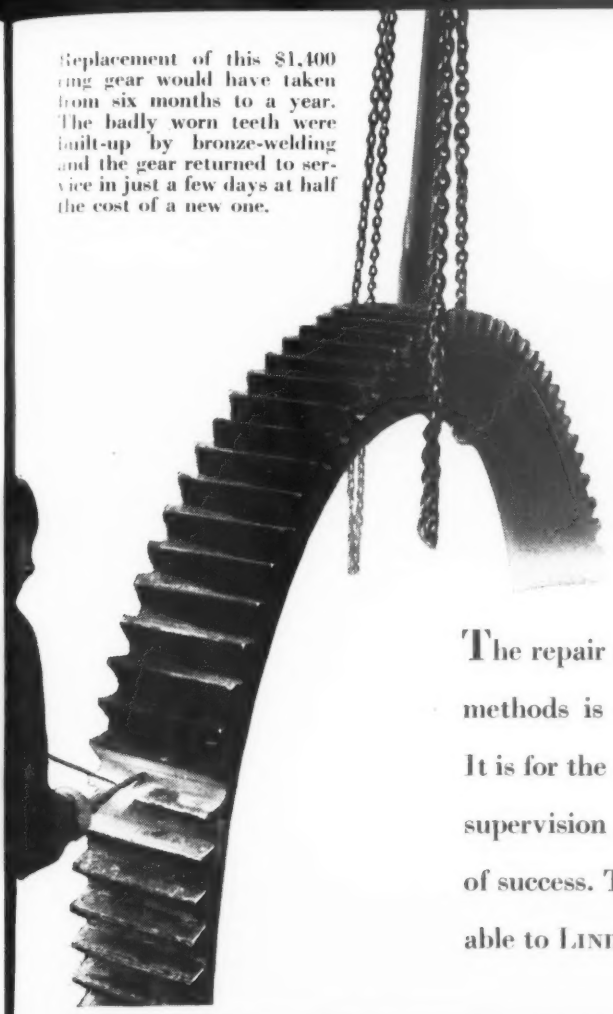
The pipe line man's freedom in making his location is greater because he is usually unfettered by grade restrictions, and for that reason there is seldom any formal reconnaissance.

Hence, from the standpoint of the man in charge of the field work, the most immediate difference is that he has no chance for "second-guessing"; unless his first location is flagrantly bad it is where the pipe will be laid. He must carry out a sort of flying reconnaissance, far enough in advance of his party to permit his spotting possible obstacles and taking steps to miss them without throwing large deflection angles, or "dog-legs," in the alignment, and he must do it without holding up the progress of his party. On pipe line surveys, "Daily Progress" is of such essence that it is a rare party chief who doesn't habitually suffer twinges of his professional conscience for the river crossing that could have been improved by backing-up a few thousand feet and throwing the line a few degrees downstream, or for the three side bends that could have been eliminated by a few hours' revision.

The party chief who doesn't chronically curse his own luck and judgment for these imperfections will not stay long in the business; either he lacks the "feeling" for good alignment, or he spends so much time in his quest for perfectionism that "Daily Progress" proves his unfitness for the work. Pipe-line surveys are running compromises between "Daily Progress" and the perfect adaptation of alignment to terrain on the shortest possible route between origin and terminus.

Broadly, these surveys can be divided into: (a) Staking the locations of cross-country main lines, and (b) "running-out" field lines and gravity systems. Normally, there is a greater degree of organization in the field party and more complex duties for the party chief in the former. The minimum personnel in open country should be party chief, transitman, head chainman, and rear chainman. This presumes accessibility to the line by automobile at least every mile, and little or no brush. Otherwise, from one to five extra men will be required for cutting brush, and for carrying stakes, lathes, and water. With stakes set every 100 ft, and lathes driven every 500 ft (mostly for the benefit of the pipe stringing crews), the two chainmen have no difficulty in carrying sufficient stakes and lathes for a mile of line.

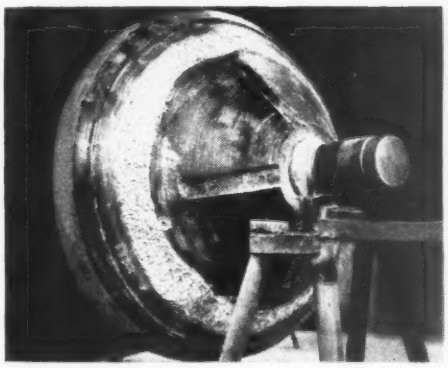
Although an experienced rear chainman is able to walk to the stake just set by the head chainman and drive it before his end of the chain arrives, an extra man is sometimes provided for the sole purpose of driving stakes. Across open country, with a fast head chainman who is unencumbered with frequent land-ties or other features of topography that consume his time in note keeping, the employment of a stake driver may be justified, and if there is intermittent heavy brush that requires several brush cutters it will be a convenience to have one of them drive stakes across the open going. Too often, however, it is expected that faster progress can be made by simply adding excess members to a party whose rate of progress is already defined by what one might call the necessary pattern of the work. For instance, in much of the brush country of southwest Texas, five good brush cutters will cut an average of about 1500 ft of "sendero" an hour. This governs the "Daily Progress." With allowance for occasional clearings and lighter brush, the average day's run will be from three to three and a half miles, whether the remainder of the party consist of three men or ten. On the other hand, in the plains country of west Texas, where the limit on progress is simply how fast a man can walk and stick stakes in the ground, it might be economical to employ an eight or ten man transit party with two transitmen "leap-frogging" each other. Under these conditions, eight to ten miles of survey per day can be accomplished. The size of the party must be fitted to the pattern of the work.



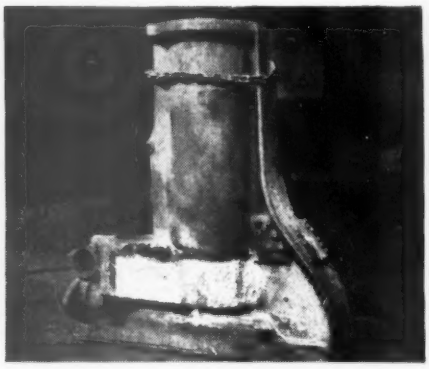
Replacement of this $1,400 ring gear would have taken from six months to a year. The badly worn teeth were built-up by bronze-welding and the gear returned to service in just a few days at half the cost of a new one.

Keeping the "wheels" going 'round

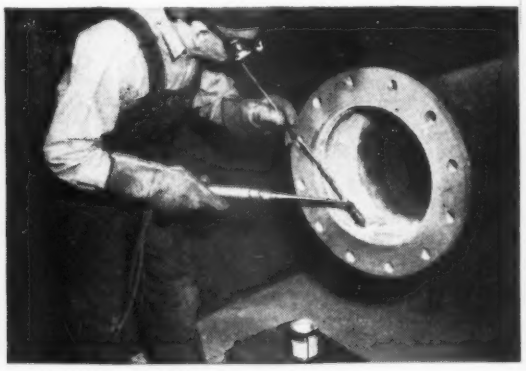
The repair of vast quantities of equipment by oxy-acetylene methods is of course routine for plant maintenance crews. It is for the special job, however, that the LINDE serviceman's supervision and work proves so valuable and gives assurance of success. This skilled, specialized assistance is always available to LINDE customers. Just phone the nearest LINDE office.



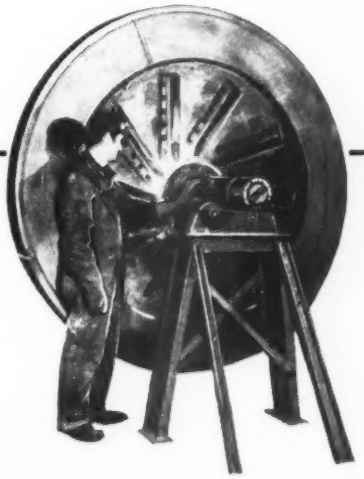
Bronze-welding this cast steel cone crusher head saved $1,000. The crack, which ran completely around the head for a distance of 9½ ft., extended through the thickness of the casting in several places. It was veed out by flame-gouging.



This cast iron steam hammer cylinder weighs 4,000 lb. Two large cracks, one on each side of the cylinder wall, were bronze-welded in only 14 hours. A new casting would have taken 16 weeks to obtain and would have cost more than 10 times as much.



Flanges are quickly joined to cast iron pipe sections by bronze-welding. LINDE supplies several bronze rods to meet varying service requirements.



Bronze-welding effected a considerable saving of cost and time when four spokes of this huge cast iron pulp-chipper wheel was cracked at the hub.

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To begin with the transitman, he should be accurate and careful, of course, but he must be those things *fast*. It should be impressed on him that his primary function is to give line to the head chainman. No matter how proficient he is he cannot, except negatively, much affect the rate of progress. By tucking the details of his own work of angle reading, etc., into the small interstices of delay in the chaining, and by briskness in getting from one instrument station to the next, he can avoid holding up the party's progress.

If the rear chainman drives his stake promptly and is ready to tail his end of the chain when it reaches him he has done all that can be asked. To do just that requires considerable knack when he is burdened with 20 or 30 stakes and a handful of lathes. The invariable error of each beginner is to drop his stakes and lathes every 100 ft in order to use both hands on the axe while driving, and the awkwardness of gathering everything up for a gallop to the next station would wear him out in a mile. A good rear chainman carries his stakes and lathes under his left arm and his axe in his right hand. As he comes up to the stake just set by the head chainman he taps it lightly to set it more firmly in the ground, and swings on it, one-handed. At the same time, he has hooked the chain out of his way with one foot to make sure it doesn't get foul with the stake he is driving, and as soon as the stake is driven he sticks his axe in the ground beside him. By then, the end of the chain will be approaching, he will have picked the chain from the ground to let it run through his right hand and when the end is some five or six feet from his hand he calls out a warning to the head chainman. In some parties, he merely calls "chain," but it is much better practice that he call out the station number of the stake he has just driven. He then takes a turn of the thong around his right hand, places his right foot slightly behind the stake in order to brace his hand against his right leg, and holds the end of the chain firmly against the driven stake. As soon as the head chainman has stretched the chain taut and set the range pole to the zero mark he calls out the station number of the stake he holds in his hand, both as a signal that the rear chainman can now drop his end of the chain and come forward, and as a further check on the correct numbering of the stakes. Insistence that the chainman consistently follow this procedure will do much toward eliminating a prevalent and annoying error in pipe-line surveys, that of misnumbered or omitted stakes.

There is more to the work of a good rear chainman than casually appears. He requires a high degree of muscular coordination and agility, but like the transitman, his contribution is negative in that he can't go any faster than the head chainman takes him. It is the head chainman who is the real spark-plug of a survey party, who drags the party along behind him, and whose ingenuity in utilizing for land-ties or note making those lost minutes while the transitman occupies a new station can be as great an element of "Daily Progress" as his briskness in chaining. In the party chief's absence, although the transitman is nominally in charge, the real organizer and tactician has to be the head chainman.

Even a judicious selection of locations for transit hubs may increase progress by a half mile or more per day, for unless there is other work that the chainmen can be doing the time spent by the transitman in "pulling-up" from his previous station, walking forward, and setting-up on the new hub is dead time; hence, the fewer stations he need occupy, the more time available for staking line. On the other hand, whenever the head chainman runs into the necessity for a few minutes delay to draw in topography or clear brush from the line, he will first set a hub and call the transitman forward even though, so far as visibility is concerned, it might have been possible to wait for another thousand feet. Similarly, he will be alert to take advantage of inequalities in contour, both to ensure that the previous back-sight will be visible and to prevent visibility forward being cut off by nearby rises.

These are small things, but the time lost in sending a flagman back to remedy an invisible back-sight may cost half a mile of progress; the time consumed in setting an unnecessary hub and occupying it means a thousand or fifteen hundred feet less line that day. Hence, the whole secret of good progress, insofar as party tactics are concerned, is physical briskness, a judicious choice of locations for transit hubs, and synchronization of activity so that, e.g. the remainder of the party is not left twiddling its thumbs while two men make a land-tie.

It might almost be said that the party chief's contribution to progress is also merely negative. Just as it is the prime duty of the other members of the party to keep their work caught up to the pace set by the head chainman, it is the function of the party chief so to organize the whole affair that the chaining is not interrupted by a lack of stakes and lathes, or by a fouled-up alignment. The good party chief, like the good navigator, will take every opportunity to verify his position, and he will build up his familiarity with the country ahead so that he can correct his alignment before trouble develops.

In thinly settled country, with few roads and trails, he will find that one of his greatest aids in avoiding alignment difficulties is a device that is not described in most surveying manuals. It is a simple and unassuming friendliness. As the appearance of a survey party is often the first intimation given a landowner of a proposed pipe line across his property, the party chief should make every effort to see him before the party has reached his property line, and long experience has proved that the most effective and disarming approach in seeking a man's permission to cross his land with a survey is to appeal to him for help and advice.

Through much of the brush-country of southwest Texas, five good axemen will average about 1300 ft of "sendero" per hour. The day's progress will run from three to three and a half miles per day whether the remainder of the transit party has three men or ten.

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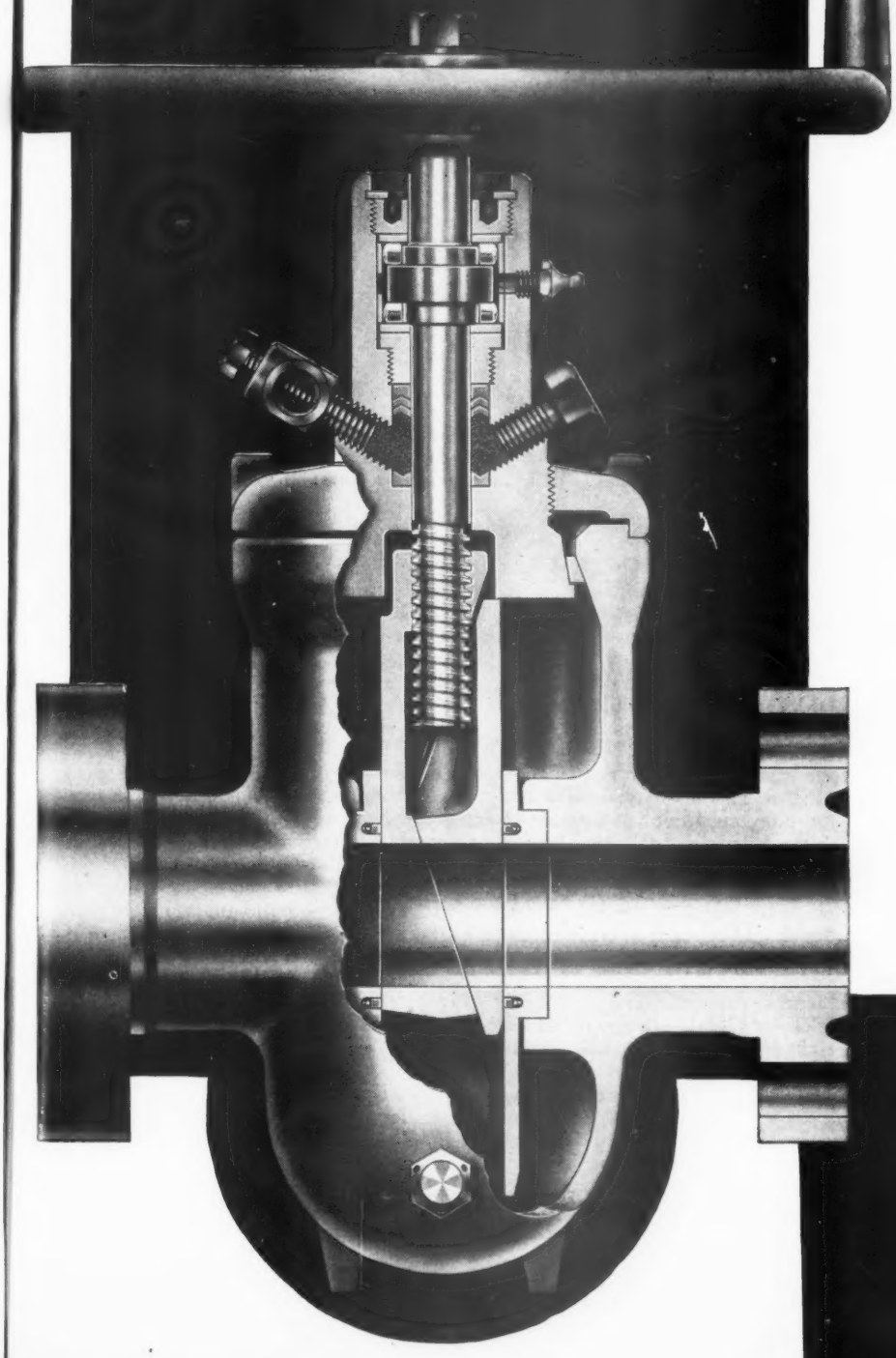
Pressure Seal Bonnet



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The head chainman is the spark plug of a survey party. He sets the pace for the others, and upon his physical and mental briskness daily progress most depends.

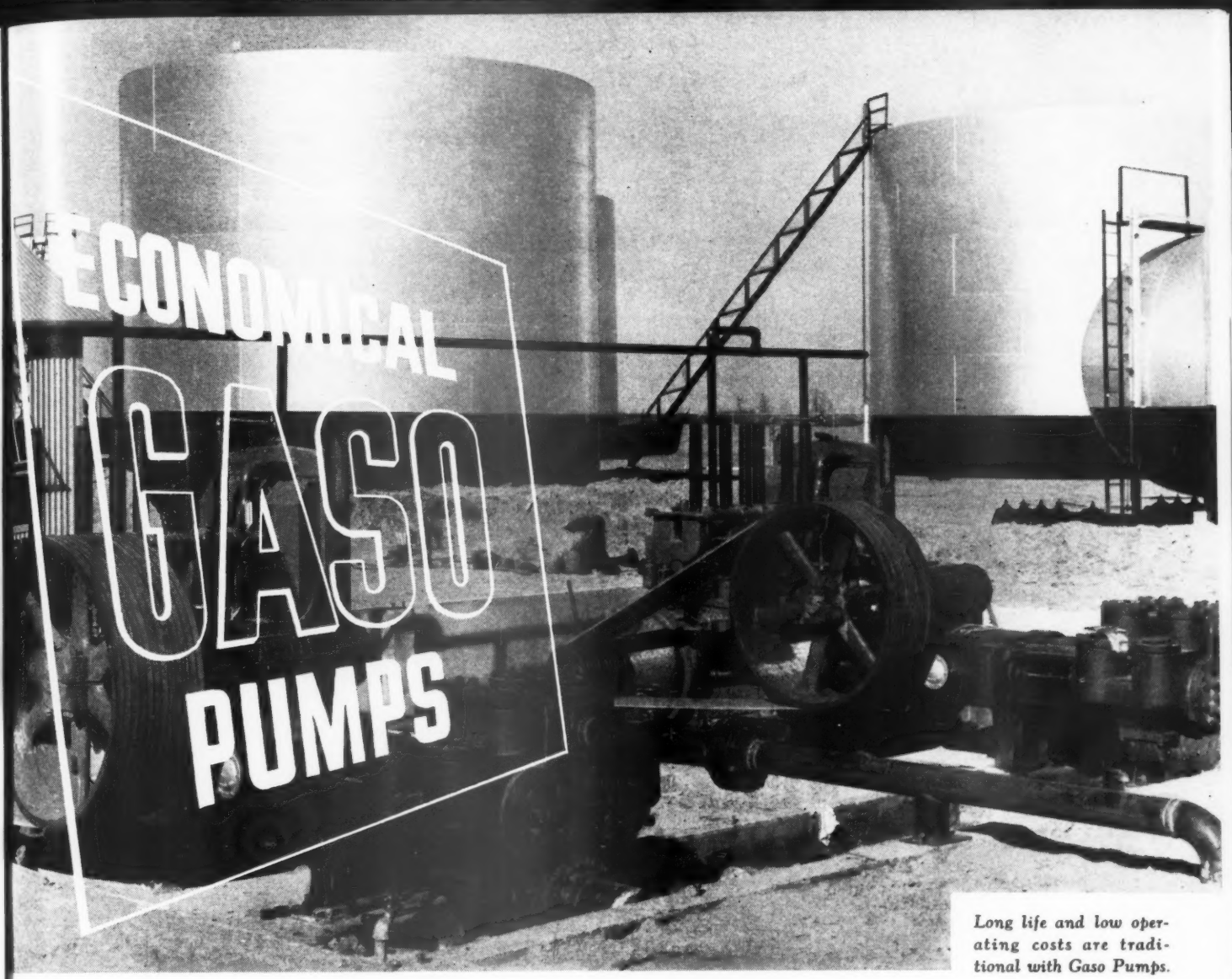
Even so small a detail as care in the location of the back-sight will be reflected in daily progress. These people are taking no chances of having to send a flag-man back from next hub.

This is not hypocrisy. The young party chief will be amazed the first time a rancher or ranch foreman has squatted down to examine the outspread map with a projected alignment upon the innocuous seeming expanse of white, has mulled over it while the party chief conceals his impatience at the waste of time, and has then announced that she won't work; she's running square up the middle of a slough that stands belly deep to a horse, this time of year, and besides, she's nicking a corner of Old Man Smith's calf trap in the next pasture, which Old Man Smith won't stand for no pipe line through that calf trap. Time spent in conversation with a man who knows the country is never wasted.

Although he must share and stimulate his head chainman's passion for "Daily Progress," the party chief should never forget the disparity in costs between surveying a mile of line and laying a mile of pipe. As the unit cost of the survey is but a very small percentage of the unit cost of the completed line (ranging perhaps from 0.5 to 1.5 per cent) he must preserve a sense of proportion concerning the time he is willing to spend on revisions and improvements of the alignment. This is difficult under the invariable pressure for speed, but he should remember that his chief objective is not to get several thousand stakes into the ground in the shortest possible time; it is to make a good location for a pipe line. The speed should come from his eye for good location, and his ability to keep his party in it with the minimum of interruptions.

At the other extreme from the "hot-shot" progress maker is a type who looks upon the pipe-line survey as an expedition for the leisurely gathering of topographic and cadastral data. Opinions and practice will vary concerning the amount of detail to be shown in the field notes. Land-ties should be made at every recognizable property line; station numbers and bearings should be given for all roads, fences, railroads, and pole lines that are crossed by the survey. As an aid to the right-of-way department in settling damage claims, the field notes should include station numbers for entering and leaving the various classes of vegetation and cultivation. Pronounced drainage features should be noted. The location and extent of rock outcrops is of interest as an indication of increased cost of ditching. Nearby artificial improvements should be drawn in, especially if they are relevant to the choice of alignment or if they present possibilities of damage claims. The definition of what is "nearby and relevant" produces variations in practice all the way from ignoring everything not absolutely on top of the line to carefully tying-in and dimensioning every out-house within 300 ft of the survey.

These two extremes of practice spring from different attitudes toward the purpose of the survey. The first man is so intent on "Daily Progress" that he is indifferent toward the needs of the right-of-way department and of the draftsmen who will have to build an alignment map from his field notes. The second man is their favorite; his notes always plat. The drafting room judges an alignment neither by the economy of its field work nor its excellence as pipe-line location but by the precision with which it plats. Naturally, the foregoing is not intended as a criticism of draftsmen, nor as justification for errors in the field work; it is merely to point out that pipe-line surveys are not undertaken for the purpose of mapping a strip of countryside. On the other hand, whenever the party chief has the slightest doubt regarding the advisability of recording some particular



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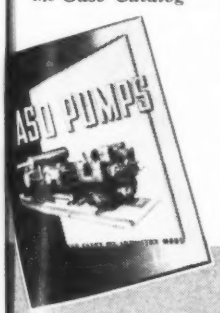

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data, he had better do so or its lack will invariably arise to plague him.

The matter of the drafting room poses the question of precision in the field work. As station numbers on the survey will be interpreted as lengths of pipe rather than as horizontal distances, it is a general practice to employ contour chaining on this work. Due to the usual method of chaining, the rear chainman holding his end of the tape against the stake just driven while the head chainman stretches the zero end against his approximately lined-in range pole, there is an uncertainty of about 0.05 ft plus or minus, in each 100 ft station. Under these conditions, the most that can be attempted is the avoidance of sloppy habits, such as a tendency of the head chainman to hold his end of the tape waist high or a failure of the rear chainman to hold firmly against the tension of a stretched tape, which produce a cumulative effect in the inevitable errors. The party chief should insist on accuracy from his chainmen, and "tight" chaining, but it is fatuous to expect precision greater than about 2 ft per 5000 ft. This is more than double the imprecision called "fair" by most manuals, but remember that our chaining is not horizontal, and we don't chain to pins.

Several allusions have been made to "good location" without any attempt to define it. A perfect location for a pipe line would be one that had no river, highway, nor railroad crossings; which lay across flat, open, uncultivated ground, and which was easily accessible to the pipe trucks in any kind of weather. The worst location closely parallels a meandering water course, which it frequently crosses or avoids crossing by numerous sidebends; it tries to cross highways or railroads where they are in deep cut; it misses a peach orchard by "dog-legging" to the right and finds itself embroiled with a waiting farm house.

The time to start ensuring a good location is before the field work begins. Wherever the proposed alignment, projected on a map, runs closely down the axis of a water course, it should be immediately suspected of harboring trouble for the surveyor, the construction crews, and the maintenance gangs. Unless an inspection on the ground proves this suspicion to be unfounded, it would be well to consider the possibility of skidding the location a thousand feet or so away from the stream. An aerial mosaic of the region provides a valuable source of information when studying provisional alignment, especially it will give a good indication of the presence of gulleys and arroyos fanning out from the water courses.

It is not always impossible to make a pipe-line crossing of a highway or railroad where the road bed is in cut, but it is always expensive and it is usually infeasible. In Texas, the State Highway Department requires a pipe line to have 18 in. of cover in the road ditches, a requirement followed by most railroads, which also specify a minimum of 3 ft between ball of rail and top of pipe. As it might be necessary to deviate a quarter-mile or more from the airline route in order to make the crossing at a point of fill, all crossings should be inspected before turning over an approved alignment to the survey party. The party chief will be sufficiently occupied with the minor tactics of dodging local, unmapped obstacles; it is unfair and poor economy to hand him an area map with a dogmatically straight line drawn from origin to terminus, and to expect him to make the major revisions that may be required for a good location.

Of course, much of the preceding discussion is applicable to any kind of pipeline survey, but there are special considerations to be taken into account in surveys for gravity systems. Some of them will be touched on in a later article.

★★★

☆ ☆ ☆

Bacteria in petroleum puts nitrogen in the soil and improves it in quality and productiveness, according to the head of a government experiment station in Texas, who calls the idea one of the most revolutionary in vegetable gardening in recent years. Oiling the soil is the most economical way to keep down grasses and some vegetables grow faster if there is a film of oil on the surface, is the claim.

★ ☆ ☆

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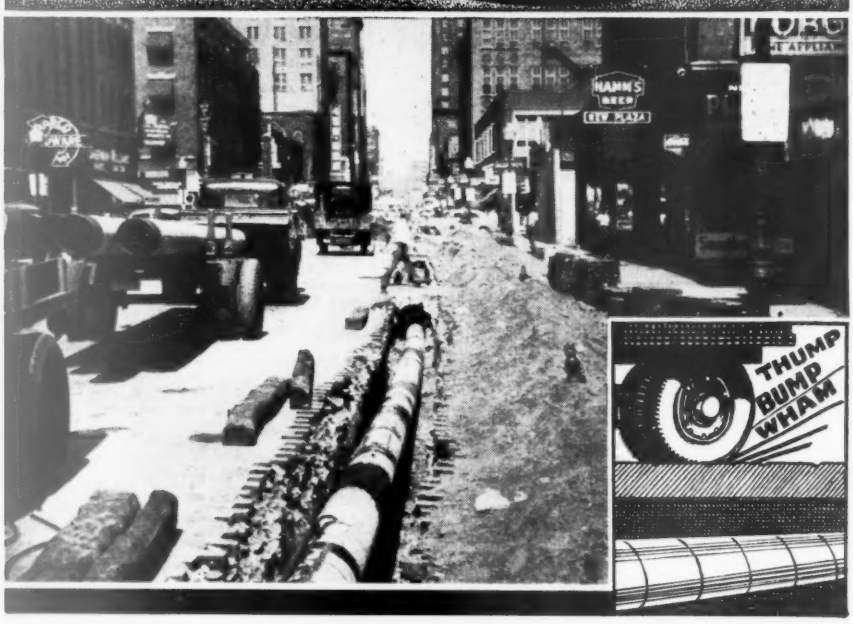

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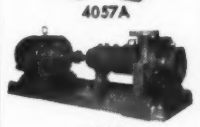

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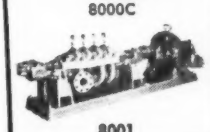

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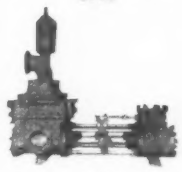

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Trends in the dehydration of agricultural products using gaseous fuels

By FRANK H. DOTTERWEICH, *Director, Division of Engineering,*
Texas College of Arts and Industries

SINCE the birth of the natural gas industry, the economic importance of the use of natural gas and its ingredients as a source of both fuel and power has been well recognized. During the prewar and war years many processes were perfected whereby these components of nature were used to prepare synthetic products for war and peace. Recently these developments have extended the use of light petroleum products like propane and butane with the resulting growth of a great petrochemical industry located principally along the Gulf Coast.

Once more the use of natural gas and its ingredients is being thrust to the fore as the perfect fuel—this time for the dehydration of agricultural products. It will be the writer's endeavor in this paper to review briefly the present advances in the process of dehydration of agricultural products. Attention will also be directed to the trends that may be expected in these operations when the postwar production and transmission of natural gas and liquefied petroleum gas is taken into consideration. In addition, an endeavor will be made to evaluate the use of modern chemical engineering processes when applied to the products resulting from dehydration procedures for the production of organic chemicals heretofore obtained with difficulty.

The great challenge that agriculture offers to the use of gaseous fuels for dehydration processing may better be understood when it is recognized that the success of any farming enterprise dictates the elimination of all hazards that might prevent delivery of a desirable product to market. The application of technical and scientific knowledge has tended to overcome many of these hazards. The two main problems to be solved are (1) prevention of quantitative and/or qualitative deterioration of the agricultural products before they are utilized, and (2) maximum utilization of waste farm by-products. Although the dehydration of farm products will find its greatest magnitude in the Southwest where abundant and cheap gaseous fuels are available, consideration of the importance of dehydration processes to the entire nation must be given. Consideration of the investment in farm lands and buildings shows this investment to be approximately three times as large as that of the petroleum industry. An interrelation of the gas industry with the agricultural interests would suggest even greater potentialities for the gas industry along with the benefits to be derived by agriculture.

The subject of dehydration of farm products and the gas industry has received attention during the first two short courses in gas technology offered in 1946 and 1947 by the Texas College of Arts and Industries, Kingsville, Texas, and sponsored by the Southern Gas Association. The major points brought out by authorities on this subject were:

1. The chief advantages of dehydration of agricultural products are: (a) Reduction in storage space with the minimizing and elimination of molding and spontaneous combustion, (b) elimination of weather hazard in complete drying, and (c) a minimum loss of nutrition value during the drying process and subsequent storage.

2. Two principal components in mixed feeds with their source are protein from alfalfa, cottonseed, peanut and linseed meal, and Kudoz; and carbohydrate from corn, milo chop, wheat, and sweet potatoes. In addition agricultural wastes like citrus and cantaloupe rinds, tomato peelings, peanut hulls, cull vegetables, and others together with the newer cacti when dehydrated add another source of valuable feedstuff.

3. Dehydrated sweet potatoes will eventually be the number one source in the Southwest of carbohydrate feed, replacing corn. Indications are that meat of superior quality will be obtained from cattle fed dehydrated sweet potatoes instead of corn.

4. Dehydration of agricultural products with gaseous fuel will allow certain portions of the country to become self-sufficient in the production of cattle feed. These dehydration units might be separately operated or set up on a cooperative service charge basis similar to cotton gin cooperatives.

5. Dehydration and quick freeze methods saving farm products from early deterioration and allowing the products to be marketed at will are of great importance to both the gas industry and the agricultural industry.

In 1940 the Bureau of Agricultural and Industrial Chemistry and the Agricultural Research Administration, Washington, D. C., began new investigations on the dehydration of foods. The objectives of their research were to discover: (1) Methods of decreasing the weight of foods, (2) ways of saving shipping space, (3) techniques for the retention of the greatest possible nutritional value of foods, and (4) how to lengthen the storage life of dehydrated products. Outstanding results have been obtained in the use of dehydration procedures to meet these objectives and these attainments are credited to contributing greatly in the winning of the war. The developments listed above are continuing as an ever-increasing variety of agricultural products are being dehydrated on a commercial scale.

The principle of dehydration of farm products is to remove a certain amount of free moisture to make the product stable against deterioration of its components.

In dehydration operations the process and to some extent the equipment required depend upon the product being dehydrated. Thus in some cases the dehydrator is directly gas-fired, whereas in others the heat is applied indirectly. For the dehydration of vegetables the tunnel dehydrator is more universally used, sometimes followed by the bin method. The following is an example of vegetables drying by this method: The vegetables are cleaned, washed, cut to a desirable size and then placed in trays that move into air tunnels. Prior to complete drying the vegetables are placed in bins to a depth of from 2 to 6 ft where hot air moves through the mass. This removes the final amount of water without agitating the product and thus allows for a desirable finished product. The drying air to the bin should have a dry bulb temperature of 120 to 130 F, with a relative humidity of 10 per cent or less to insure a controlled drying operation within a minimum period of time.

For the dehydration of forage crops, in which the tumbling and breakage is not detrimental to the end-product, the horizontal, cylindrical, rotating dehydrator may be used. In this process the product is brought to the dryer after being harvested. Suitable equipment allows it to be fed into a revolving drum where the green products comes into contact with combustion products of 1200 F to as high as 2000 F. On contact with the hot combustion gas (water vapor, carbon dioxide, and nitrogen) the green product gives up its water vapor allowing the product to be immediately and completely enclosed in a cloud of steam. This insulating medium protects its valuable organic contents from being destroyed. The product then

travels to the end of the dryer. In passing to the rear of the dryer the product is conducted through the first of three drums, which is referred to as the "hot drum." Then it turns and comes back to the burner end through a second drum that surrounds the first; then turns again and proceeds to the rear of the dryer through a third drum that surrounds the second. Such a design allows for excellent conditions of insulation while the medium is continually expanded and retards the progress until from a maximum of 2000 F the system experiences outlet temperatures of from 250 to 300 F, the interior of the product being at lower temperatures, with the material remaining in the drying drums from 3 to 12 minutes. This slowing effect is accomplished by increasing the volumes of the three drums respectively. As the product leaves the dryer it is separated from the steam and then further processed before bagging. Such a procedure limits the temperature attained in the product, and is very similar to the quick freeze process in that the cells are not burst, which results in the preservation of vital feed units. As previously noted, this process is much the same for all forage crops. Other products like citrus peel can be handled in the same manner, although they require special cutting and treating equipment prior to the dehydration process. Heating fuel requirements vary from 2,000,000 Btu per hr for small units to several times this amount for larger plants.

The quick freeze process is another method of food preservation. In quick freeze operations, however, there can be considerable waste from trimmings or grade sorting that can approach half of the original product purchased. This suggests that dehydration operations should be conducted in conjunction with quick-freeze operations to produce various forms of feed from the culls. It is of further interest to note that where natural gas or LP-gas is available these may be the more economical source of power for the quick-freeze method of food preservative.

Natural gas continues as the most desirable fuel. In the Southwest where great strides in dehydration may be expected, natural gas is available as an economical, clean, and dependable fuel. Throughout the Southwest where plants are not near gas lines, LP-gas replaces its twin of lighter molecular weight. When natural gas becomes available at a later date with pipe line extension, it may or may not replace LP-gas, as economics dictate. In certain dehydration installations LP-gas may be more desirable than natural gas when certain storage and load factors are encountered. This may be particularly true in the central states.

Trends in the natural gas industry suggest that dehydration of farm products with natural gas or LP-gas as fuel will be forthcoming in the future in those locations where economics heretofore have ruled it out. In such locations the growing season generally occurs during periods when the use of gas for heating purposes is at a minimum. Introduction of natural gas into new territories through long distance transmission lines may find desirable load factors possible with the expansion of dehydration procedures in these areas adding to its use as a fuel and source of energy. Ever-improving conditions in the LP-gas industry relative to supply, transportation, and utilization, also suggest that this fuel in turn will go far in bringing the benefits of dehydration to all agricultural sections of the country.

In the growing of agricultural products and their subsequent dehydration, modern applications of science and technology are continuous. A splendid example of the scientific growing of cereal grasses is that conducted at Evergreen Farms in the Rio Grande Valley of Texas under the able supervision of W. A. Hardin. Here a 12-month year, 7-day week, and 24-hour program of irrigation and harvesting supported by crop rotation allows for extremely high reported gross incomes yearly. This is possible, as continuous dehydration procedures are included in the total program.

According to history food drying and dehydration dates back some 5000 years. Today, essentially the same principles are employed, but far better results are achieved. The term drying is used when the liquid evolved is worthless, and distillation is used when the liquid is of value. Although the more modern term dehydration is used herein in keeping with the subject under consideration, recent developments suggest that a valuable product may be included and recovered in the by-product vapors. Thus it is possible to visualize not only the dehydration of agricultural products, but the distillation of these products as well.

In modern dehydration procedures several factors must be studied and correlated with each other. They are temperature, relative humidity, velocity of drying medium, air pressure, vapor pressure, thermal input, and moisture to be removed from the products. In carrying out these basic principles of engineering the use of natural gas and liquid petroleum gas are invaluable. The high purity of the desirable dehydrated product obtained from alfalfa allows for the commercial adaptation of some of the basic principles of chromatographic separation and extraction, yielding such compounds as the carotenes, xanthrophylls, and chlorophylls.

The theoretical foundations of chromatography, first recognized by Tswett in 1906, are based on the adsorption affinities of several substances in a common solution, each showing different degrees of activity to the same adsorbent. As an example, should green leaves be treated with a light petroleum solvent and the extract poured through a compressed column of finely powdered calcium carbonate, colormetric zones would indicate the selective adsorption of various pigments. Additional treating with the pure solvent would further define and separate these compounds. These compounds resolved upon the adsorbent can be isolated by removal from the tube with physical separation or washing the adsorbent with selective solvents. The latter process allows for the solvents, containing the single compounds, through evaporation to give up their dissolved substances. Here by chromatographic procedures is made possible the separation of substances that could not conveniently be separated by any other method.

The production of carotenoids, xanthrophylls, and chlorophylls on a commercial scale becomes evident when one considers combining dehydration of grasses and chromatography. First, the dehydration concentrates the vitamins in the base material. Treatment with a petroleum solvent, usually heptane, allows for their extraction. The solvent containing the dissolved carotenes, xanthrophylls, and chlorophylls could be run to adsorption columns where the constituents would be adsorbed chromatographically. With adsorption complete, selective solvents like hexane, benzene, methanol, and acetone in the pure state or as mixtures would allow for the successful elutation of the compounds. With the elutation of each constituent modern vacuum distillation procedures allow for the recovery of the solvent with the separation and production of the product.

The carotenoids on processing may be marketed as Vitamin A concentrates; the xanthrophylls and chlorophylls are available as additives for various types of feed. This is but one example of such a combination of processes, while other products may be produced as research goes forward in similar operations.

The use of gaseous fuels for the combined operations of dehydration and chromatography is of importance although such a combination of processes is still on a semi-commercial scale. Here the use of natural or LP-gas suggests the growth of a light chemical industry of importance to the gas industry although it may never equal or approach the heavy chemical industry made possible by natural and liquid petroleum gases along the Gulf Coast.

Trends in the dehydration of agricultural products using gaseous fuels suggest that great advances will be made in these respects in the not too distant future. The agriculture and gas industries, both active in these developments, will share in the benefits, the former by increasing the value of its product and minimizing waste, the latter by experiencing new markets for its product. The addition of a third industry, the chemical, appears imminent as an integral part of farm dehydration procedures. With such a combination select chemicals for healthier living may be obtained. The natural gas and LP-gas industries must be cognizant of these developments and ever helpful not only in the expansion of their own industry, but also in bringing about the overall condition of better living for which such opportunities provide.

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The drilling equipment situation today*

By JOHN D. SPALDING, National Supply Company

THE participation of the driller in the drilling equipment business dates back to the very beginning of the oil industry.

Before this gathering, it is fitting that we mention William A. Smith, a salt well driller, who was engaged by Colonel Drake in 1859 to complete what was to be the first producing oil well, thus becoming the first driller in the oil industry. "Uncle Billy" Smith not only took full charge of the drilling operation, but he pioneered oil well equipment manufacture by making the drilling tools himself.

The oil industry has traveled a long way from the lamp oil and axle grease era of the sixties. The industrial supremacy of these United States could not have been attained without the substantial contribution made by the oil industry.

The key to this amazing accomplishment has been a constant supply of petroleum products at a cost that has encouraged mass consumption.

To illustrate the extent of the industry's achievement in this respect, I cite the July, 1947, petroleum products price index, which is 89.8 per cent of the index value for the statistical standard base year of 1926. It is a refreshing observation in these days to know there is some commodity that is 10 per cent less than it was 20 years ago. In fact, petroleum products, as listed in the Department of Commerce Commodity Index, is the only item (excepting rayon and silk) having a price index today under the 1926 level. Compare this with the price of farm products, which increased 81.4 per cent, and all commodities, which increased 50.8 per cent over the 1926 level. The oil industry certainly cannot be charged for contributing to the higher cost of living. On the contrary, it has contributed much toward curbing the effect of rising costs in our economy.

Because the drilling operation is the largest single item in the cost of producing oil, it has provided the incentive to accomplish the efficiencies and economies that have made such petroleum price levels possible. The program agenda of The American Association of Oilwell Drilling Contractors gives evidence of the responsibility that the drilling contractor has assumed in striving for more efficient drilling practices in an effort to offset as much as possible the rising costs of labor and material.

It is significant that during the last ten years, when drilling time has been substantially and steadily reduced in all areas, the percentage of wells drilled by contract has increased from 50 to 80 per cent, indicating that the trend to contracting apparently continues. I can cite two large oil companies in California who disposed of their drilling rigs within the last year and are now contracting their wells.

Eugene Holman, president of Standard of New Jersey, presented an interesting discussion along this line two years ago in an address that was captioned in the press, "There'll Always Be a Contractor."

As a result of the accomplishments by the drilling contractor and the drilling departments of the oil companies, a large number of wells are being completed today that 10 years ago would have been considered as unprofitable risks due to their high initial drilling cost. This is particularly true in areas where production is found below 10,000 ft or where drilling formations are hard or troublesome.

It would be impossible to estimate how many additional millions of barrels of oil have been thus added to the nation's reserves. I would like to add parenthetically we should not be unmindful of the part that better drilling equipment has also contributed toward making this performance possible.

Past accomplishments are now history. It is the future ahead that must now engage our interest, recognizing that greater accomplishments are now made possible through the pooling of your experience and know-how in such conferences as you are holding this week.

The requirements of the future impose a corresponding responsibility on the manufacturer of drilling equipment to provide the kind of equipment that will make possible more efficient drilling methods. The record confirms the ability and the resourcefulness of the equipment manufacturing industry to meet the challenging problems of the future.

It is not in the nature of things to design the 1957 drilling rig in 1947. The introduction of a new design must be timely—it can be ahead of its time just as well as it can "miss the boat." The modern precision built drawworks of today would not have sold in 1925 in competition with what we knew then as an extra heavy 2-speed drawworks with wood posts, which was priced at less than $2000. The field transportation facilities of that time were not ready for the sectionalized equipment known today.

Over a period of years new equipment is introduced, incorporating improvements over its predecessor. What influences these improvements and developments? New materials alone very often make possible new products or give added utility to other products by extending their life or increasing their operating capacity. An ordnance officer made an interesting observation recently, in which he stated: "The fighting power demonstrated in World War II could be attributed in a large measure to the advance in our knowledge of metallurgy since World War I." I think you will recognize this military observation has a parallel in the advances through chemistry and metallurgy that have been made in drilling equipment and drilling practice in recent years.

Plastic coated drill pipe can be cited as a recent development in which a new product has been applied to combat the problem of corrosion fatigue, thus extending the life and capacity of the drilling string.

The recent demand for drill collars with non-magnetic characteristics for surveying purposes has been met with Monel metal, a copper-nickel non-ferrous alloy, and also with stainless steel, a chrome-nickel ferrous alloy.

The program for drilling the 20,000-ft wells of the future will include new specifications for the casing and the drilling string, which will demand "everything" the metallurgist has at his command today. The manufacture of gun tubes during the war has given the tube mills a wealth of metallurgical and processing experience which is applicable to these new tubular problems.

There are also other developments in which metallurgy has not been a contributing factor.

A development of particular interest

The author

John D. Spalding, works manager of the National Supply Company plant at Torrance, California, is a graduate in mechanical engineering from Carnegie Institute of Technology and holds an LLB degree from Duquesne University Law School. He has been associated with National Supply Company for the last 24 years, where he has contributed much to the design and manufacture of modern well drilling machinery for the petroleum industry.

*Presented at the convention of the American Association of Oilwell Drilling Contractors, Long Beach, California, October 15, 1947.

to the drilling contractor has been the modern diesel engine, which will operate either with diesel fuel or with gas that is compression ignited with injection of a small quantity of diesel fuel. Several diesel engine manufacturers in this country have been working independently on this development. An engine having the dual-fuel feature can be used equally well with or without gas being available, thus providing greater overall operating flexibility in allocating rigs to various areas. This dual-fuel engine when operating on gas seems to combine the efficiency of the diesel cycle with the efficiency of combustion that is characteristic of a gas engine. Surprisingly, the result is an engine that is more efficient than a straight gas engine and in the upper range of its capacity is more efficient than a straight diesel engine. It is reasonable to believe that more diesels will be equipped for dual-fuel operation. The dual-fuel feature has been developed for both naturally aspirated and supercharged diesel engines.

There appears to be a trend developing in drilling rig specifications calling for fewer engines with more horsepower capacity. Where 300 hp engines heretofore have been generally specified there is now observed an increasing interest in engines ranging in capacity from 400 to 600 hp. This trend seems to be justified because the larger engines provide the needed power for slush pumps and also reduce the number of units to transport.

More power does not necessarily mean a larger engine for it is now possible to obtain approximately 50 per cent more horsepower with supercharging and only an approximate 10 per cent increase in engine weight is necessary. With engines of greater capacity it is increasingly important to provide some medium between the engine and the transmission of the drilling rig that will afford some flexibility in applying the engine power. We usually think in terms of the flexibility that is possible with a steam engine as a criterion. In other words we require a medium that will absorb shock and also permit the application of full engine power against a stalled load condition. The kinetic type of hydraulic transmission provides such a medium.

Before the automobile industry in this country had introduced hydraulic transmissions on passenger cars, there were drilling rigs operating equipped with hydraulic couplings as early as 1936. Another form of hydraulic transmission known as a hydraulic torque converter was introduced on a drilling rig in 1939. During the last 10 years there has been a growing interest in various types of hydraulic transmissions applied to drilling rigs. The operating experience has been uniformly successful. The several types of hydraulic transmissions available today include:

1. **The hydraulic coupling.** This is the type incorporated in the General Motors hydromatic drive and also in the Chrysler line of cars, the latter type being known as the "Gyrol fluid drive."
2. **The hydraulic torque converter.** This type has been used in bus service principally.
3. **The Torcon drive.** This type has been more recently used in bus service and is claimed to combine the characteristics of the first two transmissions referred to.

The automotive applications of these various hydraulic transmissions are referred to primarily to distinguish more readily their applications.

The automotive industry has spent years of time and millions of dollars in developing various types of transmissions for the one purpose of obtaining some flexibility of drive in combination with an internal combustion engine. Their acceptance of the kinetic energy types of hydraulic transmissions seems to confirm the judgment and experience of the drilling equipment industry in pioneering the application of these types of transmissions on drilling rigs.

Related to but remote from the power plant transmission of the drilling rig is the drilling bit. One of the principal considerations in the design and performance of modern drilling bits is the item of weight applied to the bit. With wells of increasing depths, the percentage of error in weighing the drilling string can adversely affect the drilling performance of a bit very materially.

One recent development having for its purpose the accomplishment of more accurate weight control on the drilling

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bit is a wire line anchor for the "dead-end" in which is incorporated a direct load measuring device that is not attached to the wire line. Uniform sensitivity under all temperature conditions is claimed for this device.

There is much speculation today about the problems to be encountered in drilling the 20,000-ft wells of the future. As they relate to drilling equipment these problems seem to be fairly well resolved. Sufficient experience has been gained in the operation of existing equipment to develop the fundamentals that will apply to new equipment. There has been a steam-powered rig in operation for the past seven years that has sufficient horsepower capacity for handling the hoisting and slush pump requirements for such a well.

There is also an interest in power rigs to meet the drilling requirements for 20,000-ft wells. One of the principal problems that had to be solved on such rigs was the one of compounding power pumps. The experimental work on compounding power pumps referred to by your Rotary Drilling Committee at San Antonio has been completed. The reports on the results of the field tests were very satisfactory. With this development accomplished, we can expect to see power rigs drilling the 20,000-ft wells of tomorrow.

Time does not permit reviewing other equipment developments of interest; however, several developments which I have not mentioned are the subject of other papers before this convention.

One particular observation that I think can be drawn from recent developments is the fact that they contribute principally to more sensitive control, more flexibility in operation, and greater facility for handling heavier loads with more power, and consequently with more speed.

A discussion on drilling equipment today would not be complete without some reference to the matter of availability. I believe I can state on behalf of the drilling machinery manufacturers in the industry that there has been a very substantial improvement in the delivery situation within the last year. Eighteen months ago some deliveries were being quoted 12 to 18 months. At present, the delivery situation is more current except for special equipment requiring engineering development.

As to the tubular situation the measure of drilling activity at the present time continues to be geared to the amount of casing available. Prospects are that the present supply and demand situation will continue for some time.

The production of 18,000,000 tons of steel is reported to have been lost because of strikes in the last two years, which accounts for the acute shortage of steel. All industries are suffering because of this shortage. The tube mills, with one exception, are running almost to capacity; that is, capacity limited by

☆ ☆ ☆

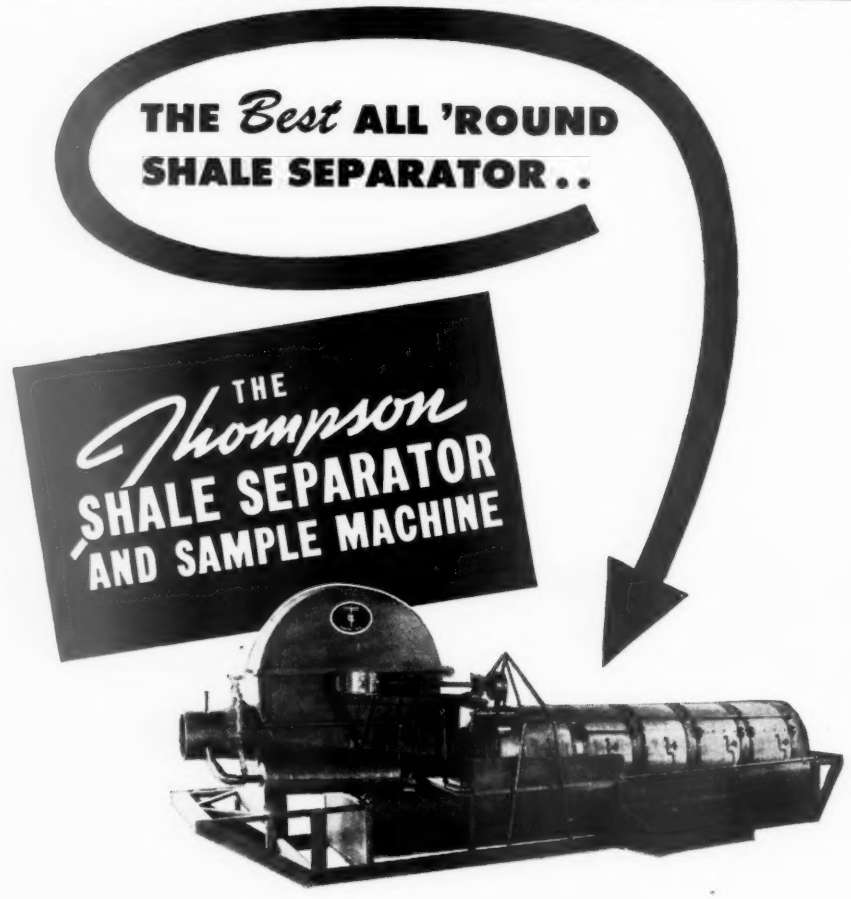
A *Petroleum Engineer* survey of U. S. oil operations revealed that more than $100,000,000 has been spent in exploring the earth's crust below the 12,000-ft level. The survey showed that 326 wells in this deep-drilling class have cost from $89,000 to more than $1,000,000 a well. Average cost was $250,000.

☆ ☆ ☆

their available supply of steel. The newspapers have reported demands from some quarters for developing more steel capacity in this country beyond the program now projected; however, even if additional steel capacity was projected two to three years must elapse before additional facilities would make their effect felt on the current abnormal demand. Notwithstanding, the 1947 forecast of 121,526,000 ft of hole drilled exceeds the previous record year of 1937 by 16 per cent.

New developments I have referred to on drilling equipment are indicative of the dependence on modern machinery and related equipment to accomplish the ultimate in operating efficiency and performance. Your investment in drilling equipment and the investment of the equipment industry in new plant facilities are a part of the 12 billion dollar increase that is reported for new plants and equipment in 1946.

These investments are gratifying indication of the confidence with which the leaders of American industry look to the future. ★ ★ ★



This new model "DW" will efficiently handle the flow of mud from the largest mud pumps now in operation. It is designed along the Self-motivated principle which was pioneered by Thompson. By removing shale and abrasives from your drilling mud, it helps to save you money . . . unnecessary wear and tear on costly equipment is reduced to a minimum. Sample Machine is standard equipment unless otherwise specified . . . the proven method of obtaining accurate foot by foot samples of cuttings and mud. Once you see a Thompson, it will become part of your Standard Drilling Equipment, for it is truly the "Best All 'Round Shale Separator." Order now . . . we can fill it!

- SELF-MOTIVATED
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- ACCURATE SAMPLES
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NEW EQUIPMENT

(1) Liquid pump

The development and production of a "Twin-Line" high pressure liquid pump, offering great flexibility in handling a variety of liquids at volumes up to 64,000 bbl per day and pressures up to 2000 psi is announced by Stanley E. Johnson, vice president and director of sales of The Cooper-Bessemer Corporation.

This new development, which is revolutionary in design and construction as compared to the conventional duplex and triplex types of pumps, is suited to a number of high pressure liquid services, according to Johnson. Among the many applications are: Oil pipe lines; pressure maintenance by water injection in oil production, and for water flooding; lean oil pumping in absorption plants; hot and cold oil charging service in oil refining; descaling service in steel mills; debarking logs in the wood pulp industry, and high pressure boiler feeding.

The "Twin-Line" design offers a comparatively large volume output and a great reduction in overall weight and space through the application of high rotative speeds to opposed, short stroke displacement plungers, it is asserted. The pump's normal speed of 400 rpm permits the economical use of a direct-connected prime mover in many installations, eliminating gear or belt speed reduction.

These versatile pumps can handle a great variety of liquids and pressure conditions. Speeds can be varied over a wide range; plungers are available in sizes from 3 to 6 in. in diam, and the pump is built with 4, 6, 8, 10, or 12 cylinders.

The "package type" valve assembly, containing both suction and discharge valves, can be removed and replaced by a spare unit in 12 to 15 min. Valve material can be varied to meet corrosive conditions. In addition, any single complete pump cylinder can be removed and replaced without disturbing any of the other cylinders.

The pump base is a heavily ribbed box-type Meehanite metal casting, providing utmost rigidity at comparatively low weight. Connecting rods are of forged steel, and all crankshaft main and crankpin bearings are of the removable, precision type, the same as used in heavy duty diesel engines. All power end parts of the pump are lubricated by a full pressure, self-contained lubricating system that includes continuous oil filtering.

The pump is 7 ft 9 in. wide, 3 ft high, and varies in length from 4 ft 8 in. for the "Twin-Two," or 4-cylinder unit, to 9 ft 10 in. for the "Twin-Six." Weights range from 14,750 lb for the "Twin-Two" to 27,750 lb for the "Twin-Six."

Accurate tests with a heavy grade of fuel oil show a volumetric efficiency of 95 per cent minimum at 400 rpm with 1500 psi discharge pressure, and still higher efficiency at lower speeds and pressures, it is stated. The mechanical efficiency is above 92 per cent.

(2) Drill collar

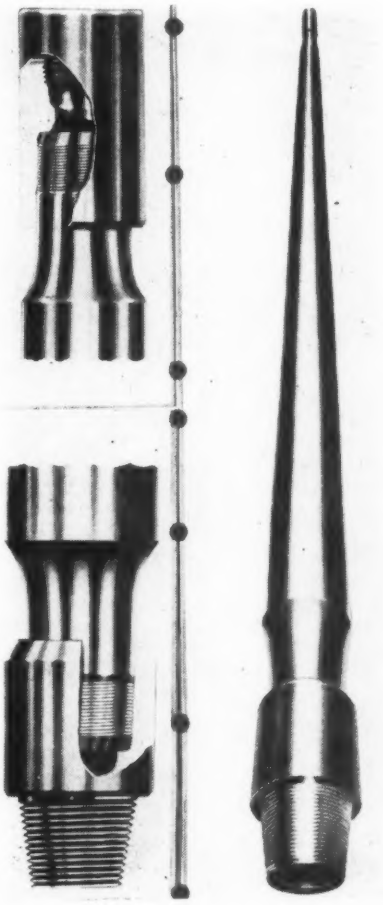
The Reed Roller Bit Company has announced a drill collar using Reed Super Shrink-Grip tool joints for drill collar connections.

The Super Shrink-Grip connection, either pin or box, is attached to the drill collar by heating and screwing on by hand. It is removed by heating and unscrewing by hand, or it can be removed with a cutting torch.

Once the drill collar is threaded for the Reed Super Shrink-Grip connection, no rethreading of the drill collar becomes necessary when worn or damaged box or pin threads are to be replaced.

The Super Shrink-Grip connections are factory made, thus providing uniform threads and dependable heat treatment.

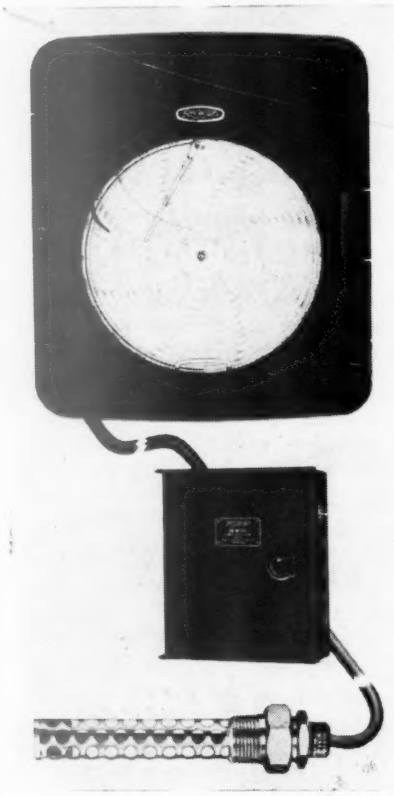
Factory applied hard metal bands to resist wear can be supplied when desired.



(3) Dew point recorders

Dew point recorders and recording controllers, said to be the first simple, continuous dew point measuring instruments available for industrial use, are the newest additions to the line of industrial instruments offered by The Foxboro Company.

The unusual feature of the equipment is Foxboro's patented measuring element, the Dewcel. It has the general appearance of a perforated metal cylinder about 9 in. long and 2 in. in diam. Within is a central tube containing the thermal bulb, wrapped with a saline-saturated woven glass tape and two windings of silver wire, to conduct the heating current. Moisture determination by the Dewcel is based on the fact that for every water vapor pressure in contact with a saturated salt solution there is an equilibrium temperature at which the solution neither absorbs nor gives up moisture to the atmosphere. The function of the variable heat supply is to bring the Dewcel to this equilibrium temperature. This temperature, measured by the thermal bulb, is transmitted to the recording instrument, and is read on the chart in degrees of dew point temperature. Recording is continuous. Various standard chart ranges are available, two of the most common being minus 20 F to plus 92 F dew point and 36 F to 160 F dew point.



(4) Utility jackhammer

A new rock drill designated as the J-10 Utility Jackhammer has been announced by Ingersoll-Rand.

This new air operated drill has been designed and built for general utility and plant maintenance work. The J-10 will do many drilling jobs in construction and maintenance work, its light weight and ease of handling make it ideal for use on a ladder or scaffold. It is well suited to overhead work.

The J-10 is a true jackhammer in every sense. It has strong automatic rotation and uses standard jackbits. By using adapters, star drills can be used to drill holes 1-⅛ in. and under. Also, by removing the rotation pawls or using round shanked tools it can be used as a light paving breaker or for chiseling and channelling. A built-in oil reservoir, in the handle, supplies ample lubrication and is one of the reasons for the low upkeep cost of the tool.

(5) Thread compound

Complete details on the new Fel-Pro "Hi-Temp" thread compound, that is said to prevent freezing and galling of metal surfaces at temperatures as high as 1800 F, are now being released by the Felt Products Manufacturing Company. The new C-5 "Hi-Temp" Compound, according to D. B. Grasett, manager, was developed specifically for high temperature and high pressure applications, such as furnace tube header studs and plugs. The data sheet cites the case of a large utility company that experienced extreme difficulty in removing studs on the world's largest steam turbine. With the application of Fel-Pro "Hi-Temp" expensive stud breakage was completely eliminated. The company states that many petroleum companies, chemical plants, railroads, and other industries where extreme operating temperatures and pressures are encountered, have tested and standardized on Fel-Pro "Hi-Temp" thread compound.

(6) Steam cleaner

A new "Utility" model Hypressure Jenny steam cleaner has been announced by the Hypressure Jenny Division of Homestead Valve Manufacturing Company. It is said to be a full-powered, extra heavy duty, all-purpose steam cleaner, and is priced at $348.00.

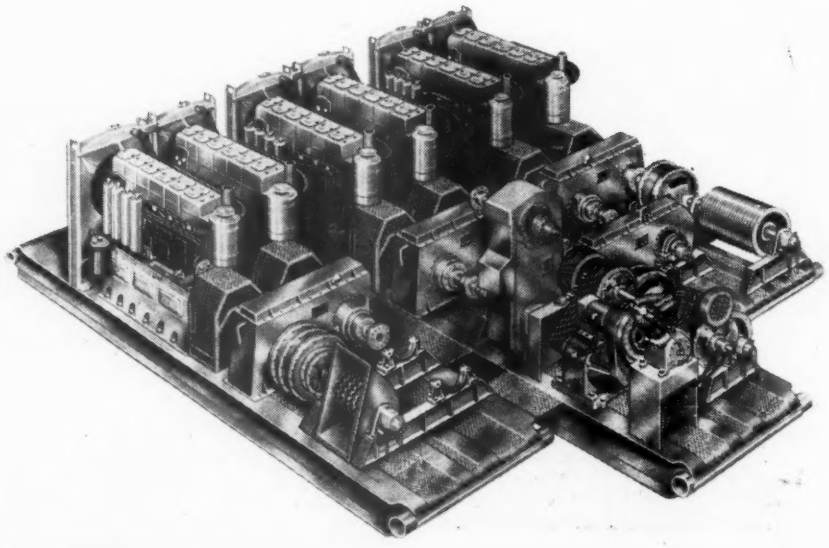
In addition to supercleaning capacity and low price, the new unit features instant starting (ready to clean in less than a minute); simplicity of design and operation; rugged welded unit construction; complete accessibility of all working parts; continuous electric spark ignition; non-clogging heating coil, and pressure atomizing oil burner.

A choice of either oil or natural gas burner, and electric motor driven or gasoline engine driven mechanism, make the new unit adaptable to most any operation requirements.

(7) Rig and pump drive

The new Mid-Continent Cummins multiple engine rig and pump drive pictured here is a practical and flexible method devised for utilizing the combined power of diesel engines for drilling and pumping. The drive, designed for drilling depths to 20,000 ft, is powered by six 240-hp Model L1-600 Cummins diesel engines and develops 1440 hp at 900 rpm. The swinging compound interconnecting each dual engine unit is an outstanding improvement in drives of this type, according to the manufacturer. There are no chains to disconnect and no guards to remove when moving from one location to another. The multiple unit can be converted into power groups for two or more engine operations without additional parts or scrapping any part of the original assembly. The whole setup can be transported on only three trucks without removing the skids.

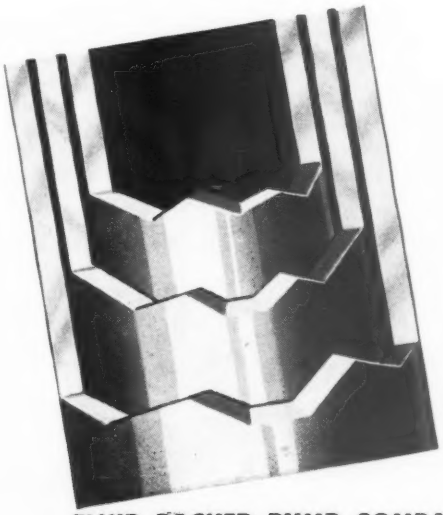
Air throttle controls at the driller's position regulate the speed and synchronize all engines with combination foot and hand throttle control for operating combined engines for hoisting. An 18-in. Fawick air clutch on each engine, controlled from the driller's position, permits speedy and complete disengagement of engine from its rotating element. Any engine can easily be removed from the drive group for repairs without interfering with continuous operation of the remaining units.

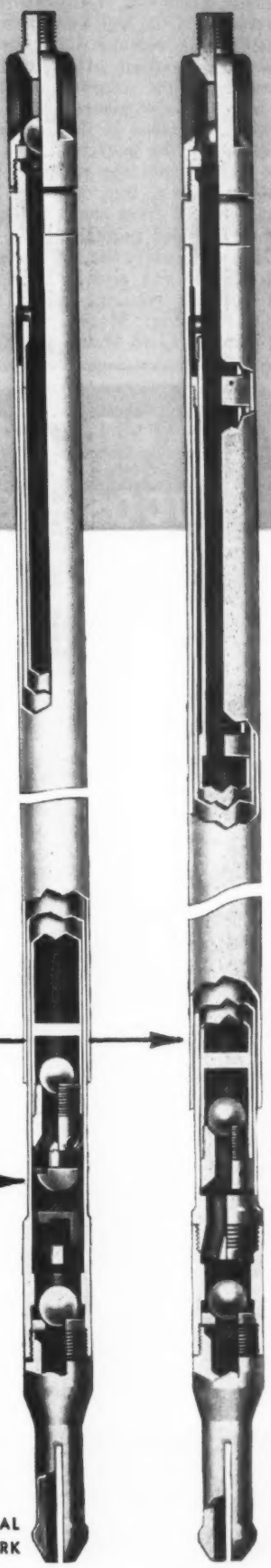


Pay off faster with oilmaster "MULTIPLE TUBE" *Fluid Packed Pumps**

***THE OIL COUNTRY STAND-BY**

FOR MORE than 20 years the Multiple Tube Fluid Packed Pump has been a favorite of production men in every hard-to-pump oil field in the world. This popularity is the result of unsurpassed performance in outlaw wells throughout the oil industry. The Fluid Packed Multiple Tube Pump has from 7 to 15 times more clearance between the working parts than the conventional, all-metal pump . . . 7 to 15 times greater space for abrasive sand particles to pass through the pump without scoring the metal surface . . . 7 to 15 times more fluid cushion between the working parts to protect them against wear.





The **POSITIVE PULL-TYPE** is recommended for general pumping conditions wherever the insert feature is desired. The entire assembly is installed and removed on the rod string.

The **REMOVABLE TYPE** is equipped with a manually operated hook-on device which makes removal of the standing tube and standing valve optional when the traveling tubes are pulled.

Illustration at left shows fluid packing in color. It is actually the fluid being pumped.

FLUID PACKED PUMP COMPANY • LOS NIETOS, CALIFORNIA

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(8) Portable pH meter

National Technical Laboratories, manufacturers of the well-known Beckman Instruments, recently announced a portable glass electrode pH meter that combines maximum accuracy and versatility with the convenience of full a-c operation. Designated as the Beckman Model H Meter, the instrument can be plugged directly into any standard 110 v. 50/60 cycle a-c. line, and can be easily transported from one location to another or installed permanently.

The Model H covers the full scale of 0 to 14 pH and can also be used for making millivolt readings within the range 0 to ± 410 mv. Measurements of pH can be made to an accuracy of 0.03 pH unit, and millivolt readings to 2 mv, thus providing unusually high operating accuracy. A neutral position on the switch disconnects the indicating meter from the electrical circuit to avoid excessive swinging of the meter needle during warm-up periods and when changing test samples or electrodes.

Standardization with one buffer gives accurate measurements over the full range of the instrument, thus eliminating cross checking between two buffers. The instrument may be checked and corrected for drift at any time by simply pressing a button on the electrode terminal and bringing the needle to the pointer position with the standardization control.

(9) Trulevel Gage

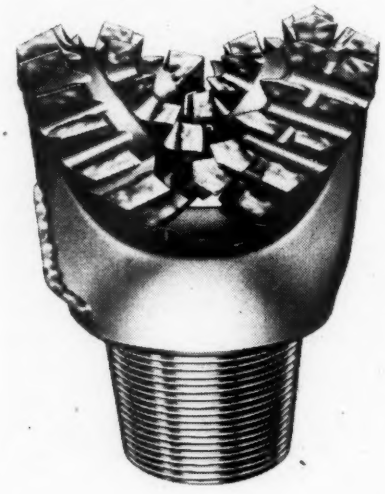
The new Jerguson Trulevel Gage is the only boiler level gage that can be read and quickly checked at the remote reading point, says James Ford, sales manager of Jerguson Gage and Valve Company in connection with the company's announcement of this new product.

The checking feature is patented and exclusive with Jerguson, according to Ford. It is necessary only to turn the two checking valve handles on the cover of the Jerguson Trulevel Gage in order to check the water level with complete accuracy, and in a matter of only seconds. This remote reading and checking of boiler water level is guaranteed correct because the Jerguson Trulevel Gage is provided with a new type of datum column located at the drum, it is stated. This datum column is full steam jacketed, duplicating the temperature and specific gravity conditions existing in the boiler drum. As a result, dead sure accuracy of gage reading is assured, according to the company's announcement.

(10) Globe rock bit

A large bearing area, together with larger ball and roller bearings, are features of the new Globe 2-cutter rock bit that, the Globe Oil Tools Company states, enable it to stay on bottom longer.

This new Globe rock bit is outstanding in its ability to make hole under the most severe drilling conditions, according to the manufacturer. Cutters are designed to dig fast, and their long,



well spaced teeth are constantly kept clean by the circulation, making them exceptionally efficient even in the stickiest formations. This feature is particularly advantageous when streaks of sticky shale are encountered that tend to "ball up" the bit.

Another feature is its ability to dig straight hole and to bring a crooked hole back to vertical.

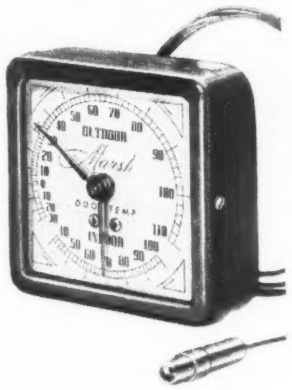
Geophysical drilling crews use the Globe 2-cutter rock bit in the small sizes (4¼ in. and 4¾ in.).

The bit is manufactured in three different types: Type SS-2C for soft, sticky shales; Type S-2C for medium to hard shales, and Type M-2C for hard shales.

(11) Marsh thermometer

An unusual and highly practical thermometer that registers both indoor and outdoor temperatures is now available. Called the Marsh Duo-Temp thermometer, this instrument is designed for the home, apartment, or private office. It may be placed at any convenient location and is as easy to read as a mantle clock.

The face of the Duo-Temp is divided into two separate temperature ranges.



The top range indicates the outdoor temperatures and the bottom range shows the indoor temperatures. Outdoor temperatures are shown in black and indoor temperatures in red to set off the two temperature scales and to further enhance the attractiveness of the unit.

The thermometer is manufactured by the Jas. P. Marsh Corporation.

(12) Plug valves

The H. K. Porter Company, Inc., announces the development and production of an advanced design of lubricated plug valves. These valves assure complete and leak-proof shut-off, elimination of leaks through the stuffingbox, ease of operation, and trouble free service, it is asserted.

This new design is particularly applicable to manufactured and natural gas operations, refinery installations, oil production, and the chemical and processing industries. The valve is available in semi-steel, carbon steel, alloy, and stainless steels.

(13) Transmission belting

Hewitt Rubber Division, Hewitt-Robins, Inc., has announced improvements in its line of flat transmission belting with current production featuring the return of Monarch Amber belting that was restricted during the war. J. H. Hayden, vice president in charge of sales, said Hewitt is now producing four top brands of transmission belting, Monarch Amber, Monarch Neoprene, Sagamore, and Ajax.

Monarch Amber is of straight-edge construction, extremely flexible, and is built of premium grades of extra strength hard silver duck. All plies are insulated with highest quality pure gum rubber compound.

Sagamore belt is made of pre-stretched premium quality hard silver duck plies, frictioned and skimmed with high quality pure rubber compounds. It is made in the folded edge construction for those who prefer this type.

Monarch Neoprene belt is of the same general construction as Monarch Amber, the only difference is that Neoprene is used rather than natural rubber.

Ajax is a top quality folded edge transmission belt made of high-tensile duck, frictioned and skim coated with first quality rubber compound.

Hewitt transmission belts are made endless by a special "drum-splice" method and are available in 500-ft to 550-ft rolls.

Fabricated
LIKE THE TIRE
on your car!
THAT'S WHY THIS "AMERICAN"
PACKING ELEMENT RETURNS
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WHEN THE CONE
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Exclusive with "American" — The packing element in this Type G Packer is designed to take advantage of modern tire fabrication principles. Examine a cut-away section of this element yourself. See how it is constructed of alternating layers of rubber—with fabric cut and placed on the bias, a feature which enables the element to readily return to its original shape when the cone is removed.
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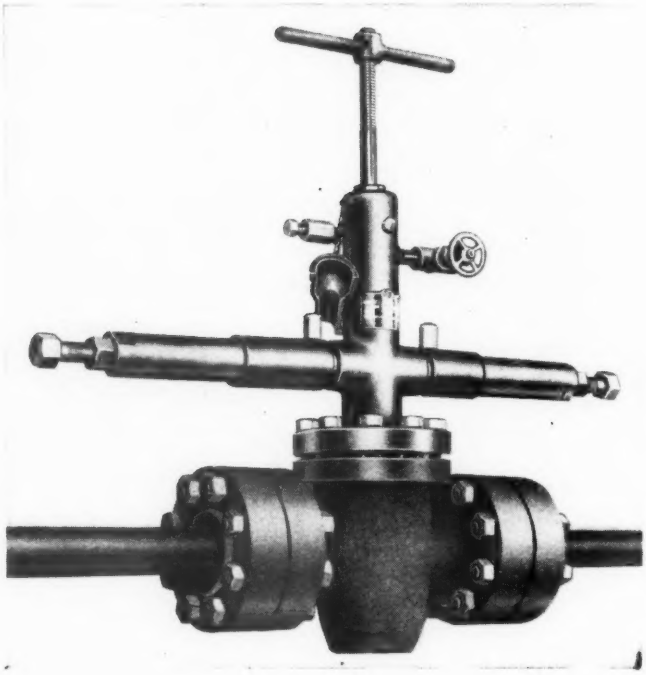
Remember, there is an AMERICAN service man in every active field!!

(14) Surface safety valve

Otis Pressure Control, Inc., announces the sale of a new heavy duty automatic surface safety valve designed to prevent line breaks caused by excessive pressure increase, or to shut off a broken line.

Various applications include a 2-in. Otis surface safety valve installed with surface connections on a two-zone well in the Opelika field, East Texas, where it is being used to prevent the packer from unseating. The upper oil zone of this well has a flowing pressure that is considerably less than the shut-in pressure of a lower gas zone. A flow line from the latter is connected into a compressor plant. Previously, freeze-ups in this line had shut in the lower zone and created a wide pressure differential that unseated the packer. The Otis surface safety valve is installed in the flow line from the upper oil zone and is operated by pressure from the lower gas zone. Thus, in the event the gas line freezes up, or should the lower zone pressure build up to a level likely to create a wide pressure differential across the packer, the safety valve will automatically close in the line and shut off flow from the upper pay. Bottom-hole pressure will then build up above the packer to a level high enough to hold the packer securely in place.

Another installation, serving as an essential safety measure, is the use of a 2-in. 10,000-psi test Otis surface safety valve, equipped with both high and low pressure pilots, to protect a long flow line in the Old Ocean field, Texas, which crosses a main thoroughfare within the city limits to enter a gasoline and cycling plant. Corrosion and freeze-ups are prevalent in the 2000-psi line. The Otis surface safety valve is preset to shut off automatically the line in the event leaks, breaks, or freeze-ups cause pressure to increase above or decrease below predetermined safe limits.

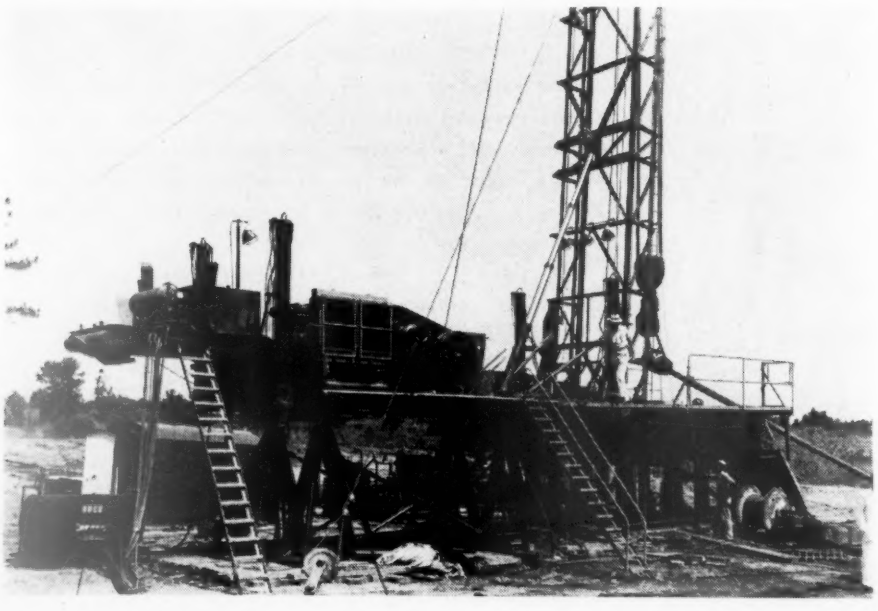


(15) Hy-Lift rams

Ideco's Rambler Rig can now be equipped with Hy-Lift rams to elevate the entire rig a sufficient height to permit the placing of a substructure. This supersedes the conventional method in which the rig is rolled up a ramp onto the substructure.

Semi-trailer mounted Hydrair hoist with the Kwik Lift mast, one of the Rambler Rig models, is equipped with four hydraulic rams, one mounted at each corner. The rams, trade named Hy-Lift rams, will lift the entire unit 8 ft in a single stroke and provide a floor elevation of 9 ft. Centralized control permits proper coordination of the four rams. Safety measures have been provided for proper lowering of the rig. The entire unit can be raised from ground level to full ram extension in 8 to 10 min.

Features of the Hy-Lift ram system are the saving in time required for rigging up and the reduction in weight in substructure requirements.



(16) Block assemblies

Guiberson Corporation's line of interchangeable parts for use with the new unitized tubing block and hook is now complete, it is announced by Al Pranger, general sales manager for the company. Quantity production of the spring hook assembly, last of the companion items, has now been achieved, he states.

He revealed that the concept of many operations requiring use of a tubing block being made simpler by making hooks, shackles, bails, etc., easy to alternate according to need, decided Guiberson many months ago to manufacture complete block assemblies. Beginning with the block itself, in both single and double sheave models, the company has engineered and put into production a line of assembly parts now made complete by the spring hook assembly, Pranger reports. Available with the highly streamlined blocks are units allowing combinations ranging from a simple block and becket assembly to a block and spring hook. All parts are matched in design and incorporate maximum safety characteristics, he said.

(17) Furnace controls

Complete L&N temperature and combustion control systems for large industrial furnaces now include a new air-fuel ratio controller that has the features of simplicity, accuracy, and sensitivity. Like the Micromax pyrometers and L&N furnace pressure controllers with which it operates, this controller employs electric-motored valve drives—needs no hydraulic piping.

EMSCO UNIT PUMPERS

BETTER *Balance* MEANS SMOOTHER PERFORMANCE

▲ Emsco Unit Pumpers are equipped with wing type counterbalances for easy and accurate adjustment—*providing consistent proper balance.*

▲ Any position between zero and maximum counterbalance effect provided.

▲ Emsco Unit Pumpers are shipped with weights attached to crank —*easier installation.*

▲ Pumpers are roller bearing equipped throughout and are provided with herringbone gears.

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trade literature

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(18) Oil measurement

Just issued by Oil Weigh Meter Company is an interesting booklet that discusses the essentials of oil measurement for production purposes, and the specific need for accuracy in such measurements in order that the most economic operation may be assured. It is pointed out that overall efficiency is not possible without knowledge of individual well performance. The new type Oil Weigh meters for providing this information are designed to be used in open tanks for heavy oil, or under pressure where desired for the handling of highly volatile fluids. In the latter case, the meter also acts as an oil and gas separator, and since measurement of the oil is by weight the entire process is independent of temperature. Late models are also provided with automatic samplers.

(19) "Pipeline Construction"

Vital pipe lines, carrying oil and gas, now network the nation, bringing the great natural resources within reach of every consumer and minimizing the cost of transporting such important fuels to the far corners of the country.

A description of many of the pipe line laying jobs around the country is given in the new Caterpillar Tractor Co. publication "Pipeline Construction." The booklet presents some of the major operations in the field and stresses the power required to make success possible. The reader is given an idea of the proportions of the tasks accomplished by "Caterpillar" and allied equipment in the 8-page publication.

(20) Texrope drives

A new 144-page, indexed catalog for "pre-engineered" stock Texrope drives, which simplifies drive selection so persons untrained in V-belt engineering can readily specify proper drives, has been announced by the Allis-Chalmers Manufacturing Company.

Nearly two-thirds of the new book is devoted exclusively to pre-engineered stock Texrope drives for all applications from 1 to 150 hp. More than 22,000 stock drives are listed in this section. Drives for all horsepowers, motor speeds, ratios, and driven speeds have been accurately pre-engineered and are systematically listed according to horsepowers.

Recently announced new pitch diameter sizes of B and C Magic-Grip sheaves are used in many of these drives and have greatly increased stock drive selection possibilities.

(21) Sweetening process

The Air Reduction Company has announced the publication of a new folder, complete with diagrams, that fully explains the use and application of the Airco-Hoover copper sweetening process. This process is the original method of "sweetening" malodorous oils by bringing them in contact with copper chloride, it is stated.

(22) Field compressor stations

Clark Bros. Co., Inc., has published in bulletin form an article entitled "Field Compressor Stations", written by C. S. Worley of the Consolidated Gas Utilities Corporation, Oklahoma City, Oklahoma. The article first appeared in the March, 1947, issue of *The Petroleum Engineer*. In the article Worley states the case for the field compressor station briefly and in understandable language. The subject should be of interest to everyone connected with production and transmission of natural gas.

(23) "Tool Steel" process

"Tool Steel" process sheaves and pins is the subject of a bulletin by The Tool Steel Gear and Pinion Company. "Tool Steel" parts are hardened to meet severe requirements, according to the bulletin. Each part is made from low carbon steel, is subjected to the exclusive and special "Tool Steel" process to effect maximum surface hardness and depth of case, then further treated for maximum core refinement.

(24) McKissick catalog

McKissick Products Corporation has issued catalog No. 48, in which are illustrated and completely described blocks and oil country specialties manufactured by the firm.

(25) Ucilon protective coating

United Chromium, Incorporated, has issued a bulletin on Ucilon, a protective coating for severe corrosive conditions. Ucilon is an organic coating material especially formulated from synthetic resins. It is used in the refining industry for coating tanks, agitators, and other equipment subject to acid and caustic spillage. It is also used in the chemical industry, as well as many other industries.

(26) Vogt water tube boiler

Henry Vogt Machine Company has issued a bulletin on its Class LE water tube boiler. This type boiler is best adapted to installations where there are no space limitations. The bulletin is freely illustrated with photographs and drawings.

(27) Combustion unit

The National Airoil Airocool Tandem Combustion Unit is the subject of a pamphlet by National Airoil Burner Company. According to the manufacturer, the unit will operate with (1) high combustion efficiency using either gas or oil fuel, (2) a minimum of furnace draft and low excess combustion air, (3) all grades of gas fuel at 5 psi or higher pressure, (4) all grades of oil fuels, also sludges and refuse oil, and (5) smokeless combustion even on low settings.

(28) Built-in motors

The Louis Allis Company, Bulletin 516-D, describes the line of type "CT" rolled shell, shaftless squirrel cage induction motors for built-in drives with details of electrical and mechanical features, mounting, ventilation, and applications.

(29) Connectors for grounding

"Connectors for Grounding" is the title of Catalog G 47, published by Burndy Engineering Company. The 32-page catalog presents the company's broad line of grounding devices. In addition, the Burndy publication provides a comprehensive discussion of modern grounding practice heretofore not available between the covers of one publication.

(30) Steel shelving catalog

A 6-page circular listing steel shelving has been published by Precision Equipment Company. Steel shelving in a variety of sizes is offered for prompt delivery—and some sizes are currently available for immediate shipment from stock.

(31) Protective coating catalog

A 12-page catalog giving complete details on the chemical and physical properties, application instructions, and other pertinent data on protective coatings has been made available by Amercoat Division, American Pipe and Construction Company. Catalogs are available for ten major industries, giving full technical information pertaining to each industry.

(32) Oil cargo handling hose

A new catalog section on its oil hose for cargo handling has been published by The B. F. Goodrich Company. The combination suction and discharge hose described in the section is one of the most highly specialized products of the rubber industry, since the service conditions in transporting oils and gasolines are extremely severe. Types described include dock loading, sea loading, and hose for barge service, as well as the fittings that go with them. Data on each type is included.

(33) Guiberson equipment

The Guiberson Corporation has announced release of its new catalog of oil field equipment. Containing accurate and colorful drawings of each Guiberson product, the booklet offers a complete presentation of the extensive list of tools and parts, including specifications and prices, it is stated.

The catalog presents the company's equipment in three sections, a method contrary to previous practice. Production equipment is first shown, followed by a section devoted to drilling tools and supplies. The last portion of the booklet lists miscellaneous products such as unions, adapters, etc.

Champion

IN THE SEALING AND CAVING DIVISIONS

CAMERON *Flex-Seal*

. . . the One and Only MUD VALVE

There's just one mud line valve . . . Cameron "Flex-Seal." Unlike ordinary all-purpose valves and stop cocks, this valve was designed expressly to withstand the abrasive action of drilling fluid moving at high velocity. No metal valve seats should be expected to withstand, for any appreciable time, such destructive force. But 'Flex-Seals" employ a resilient flow-way insert which slowly absorbs the abrasive action of drilling fluid. When finally worn out, the insert may be replaced at the rig by any member of the crew. This renewable insert also provides a pressure-tight seat for the gate and seals the two-piece valve body.

Hubs of the "Flex-Seal" valves are attached to the body by means of interlocking shoulders and grooves which permit the valve to swivel when making up a manifold. This design permits changing from screwed to flanged, weld-on or any other type connection desired in the field. These are some of the reasons why "Flex-Seal" valves have been universally accepted as the mud line valve. Complete details will gladly be sent on request.

CAMERON IRON WORKS, INC.

P. O. BOX 1212, HOUSTON, TEXAS

West Texas: Midland (Telephone 1982). *Oklahoma:* 3
ach (P.O. Box 267). *Wyoming:* Casper (P.O. Box 701
: Bossier City (P.O. Box 425).

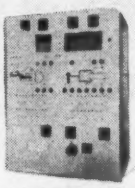
Falstrom presents

NEW TRENDS IN
CABINET DESIGN

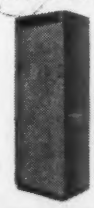
From FALSTROM ENGINEERING FILES

No. 2—DELUXE STEEL CABINET PRECISION TEST STAND

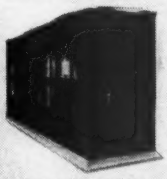
A fine enclosure such as this superb example sometimes begins—on the drawing board—as an overcomplicated, expensive design in an effort to achieve individuality. This tendency produces such details as large curves in three planes, difficult decorative bends, and unnecessary surface breaks—all of which should be excluded especially where price is a factor. See how cleverly these costly additions have been replaced by simpler design in the cabinet shown. This unit is comparatively easy to build even in small quantities yet possesses a beauty and distinctiveness which is part of its simplicity. It will pay you to use this kind of Falstrom know how in steel cabinet design. Write for illustrated catalogs.



HEAVY PANEL WITH MIMIC FLOW DIAGRAM



COMMUNICATIONS EQUIPMENT CABINET



HEAVY DUTY PUBLIC UTILITY CUBICLES

DESIGNERS.. ENGINEERS.. BUILDERS..

FALSTROM COMPANY
Steel Housings since 1870
7 FALSTROM COURT • PASSAIC • NEW JERSEY

(34) Load and pressure cells

The Baldwin Locomotive Works, Testing Equipment Department, announces three new bulletins that describe and illustrate its three types of load cells:

Bulletin 264, 4 pages, covers the new Tate-Emery air cell, an independent tension and compression load-weighing device that extends the precision range of testing machines to low values of load.

Bulletin 271, 2 pages, covers five sizes of the new or SR-4 load cells in which the SR-4 bonded resistance wire strain gage translates changes in tensile or compression loads into changes in electrical energy.

Bulletin 270, 2 pages, covers five sizes of the new SR-4 fluid pressure cell that converts pneumatic or hydraulic pressures in pressure vessels, pipe lines, etc., into changes of electrical energy by means of an SR-4 bonded resistance wire strain gage element.

(35) Sier-Bath screw pumps

A revised 20-page catalog of Sier-Bath screw pumps has been published by Sier-Bath Gear and Pump Company. It gives full descriptions, capacities, and uses of Sier-Bath internal and external types, horizontal and vertical, for pumping crude oil, Bunker C fuel oil, greases, paraffins, syrups, molasses, acetates, cellulosics, and semi-fluids for processing. Also included is information on horsepower ratings, viscosities, pump installation, and maintenance.

(36) Corrosion resistance computer

A new tool for judging corrosion resistance of nonferrous and stainless steel alloys is in easy-to-operate slide rule form. V. A. Spoehr, general sales manager of the H. M. Harper Company, announces the free distribution of the new Harper computer of corrosion resistance as "an invaluable aid to men who buy or specify metals to be used in corrosive environments." It is based upon exhaustive tests made by one of the foremost metal men in the country and classifies the resistance of 13 nonferrous and stainless steel alloys in 142 corrosive applications with degrees of excellent, good, fair, and no good. Copious footnotes broaden its scope of applications to include most of the common uses and many unusual ones.

(37) Cummins diesel engines

Distribution of the second 1947 issue of "The Dependable Diesel", a magazine for power users published by the Cummins Engine Company, Inc., is now being made by Cummins dealers throughout the United States.

The magazine contains nearly 50 photographs of typical applications of Cummins diesel engines. It includes stories about such users of diesel power as Ayrshire Collieries Corporation, Big West Drilling Company, Pacific Intermountain Express. The Silver-Skagit Logging Company, Ltd., and others.

(38) Plastic-coated drill pipe

The story of how the Spang-Chalfant Division of The National Supply Company developed its plastic-coated drill pipe for drilling oil wells in highly corrosive fields is told in a 22-page booklet recently issued by the company. The thermosetting plastic, which is applied to the inside of the pipe, resists the corrosive action of the acids, alkalies, and salt picked up by the drilling fluids and thus prevents fatigue cracks that may result in pipe failure and a costly fishing job.

Following the success of the plastic-coated pipe for drilling oil wells, Spang-Chalfant has developed a similar coating for tubing used in producing wells, and is continuing its research to adapt the coating to pipe used in many other industries, including home and industrial construction.

(39) Hinderliter bulletins

The Hinderliter Tool Company Division of the H. K. Porter Company, Inc., announces the release of a new bulletin on Hinderliter Type "XF" tubingheads. These tubingheads are designed for suspending well tubing by the hanger method, using lockdown screws in the top flange of head to secure hanger in seat and provide positive down thrust to assure adequate compression at all times for the rings of packing on hanger.

The company also announces the release of a new bulletin on the Hinderliter Type "Y" casinghead. This casinghead is extremely compact and efficient, having a minimum number of

parts, and it provides an economical means of safely supporting and packing off casing strings on wells of medium depths and pressures.

The Hinderliter Type "HW" two-in-one tubinghead, which has a full opening body designed to withstand 4000 psi test pressure or 2000 psi cold working pressure, is described in another bulletin by this company. The design and construction of this head permit sufficient diversification to justify its use for pumping production, for flowing wells, for acidizing, and for repressuring projects.

Another bulletin gives details of the Type "Z" casingheads. This casinghead is designed to support a maximum weight of 6000 ft of 7-in. casing, with an internal bore of sufficient diameter to pass casing couplings and casing centralizers.

Hinderliter Tool also has released a new bulletin on Type "W" and Type "HWF" casingheads.

(40) Oil, gas, water well supplies

The complete line of oil and gas well packers, sand pumps and drilling tools, and water well supplies manufactured by Larkin and Company, is presented in a new catalog. The 88-page book gives technical descriptions, pictures, and prices of all equipment. Discount sheets of complete new pages will be issued periodically to keep the prices in the catalog up to date. Pages covering new equipment will be also issued for catalog insertion.

(41) Technical data book

A 16-page technical data book on the Capacilog, "Electronic Scriber", has been released by Wheelco Instruments Company. Operational diagrams, schematic drawings, charts, and listings explain the diversified functions of the company's new strip chart recorder. The operation of measuring systems as deflection, potentiometer and resistance thermometer, electronic circuit and recording system are treated individually. Control switching actions are shown on a simplified diagrammatical chart. A section of the book gives instrument specifications and mounting dimensions.

(42) Pumping dual wells

Otis Pressure Control, Inc., has available a 4-page two-color reprints of an article "Pumping Dually Completed Wells", which describes in detail the use and application of Otis pumping equipment especially designed and manufactured for effective operation in dually completed wells. Otis two-zone pumps can be used to pump one or both producing formations without commingling fluids; or, they can be used to provide a means of recompleting single zone wells as dual producers.

(43) "Power Points"

Engineers, equipment designers, and manufacturers with engine application problems will be interested in the publication "Power Points", an interesting, fully illustrated booklet describing a new 10-hp engine developed and manufactured by D. W. Onan and Sons Inc. One section of the publication describes the "CK" in action and includes many photographs and illustrations of the engine in use.

Included is "The Story of Power", which traces chronologically the age-old struggle of man to harness power. "Power Points" is published in the interests of engineers and manufacturers who have or will have power problems to meet.

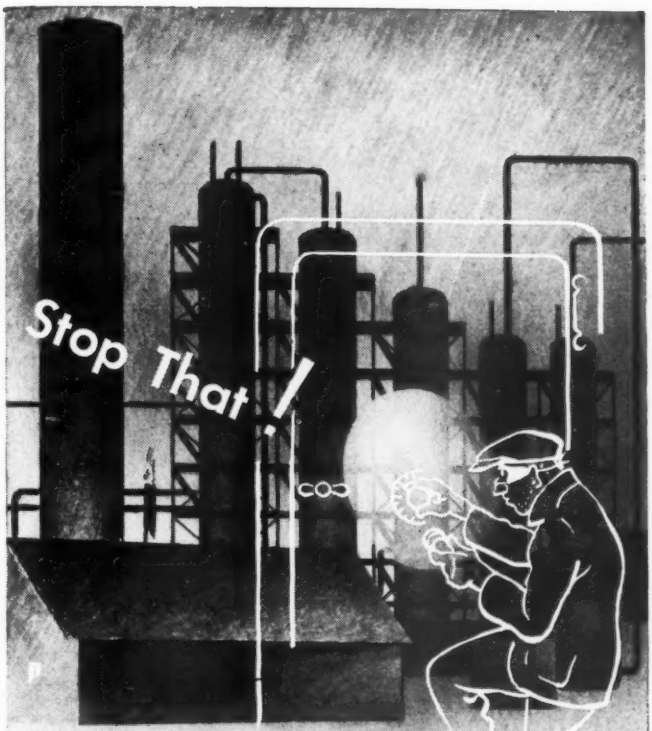
(44) Building maintenance problems

The 15 most urgent building maintenance problems are illustrated and discussed in a colorful, informative folder that will prove of interest and value to every plant owner, engineer, and maintenance man. Included in this practical guide are the solutions to such problems as leaky roofs, worn flashings and gutters, rough concrete and wood floors, concrete dust, spalled walls, loose pointing, etc. The folder, "15 Building Maintenance Problems", is issued by the Stonhard Company.

(45) Centrifugal pump catalog

Dean Brothers Pumps Inc., has issued a new catalog describing its complete line of centrifugal pumps for industrial, chemical, petroleum, and general service. This catalog is No. 200.

The catalog includes photographs, cross-sections, selection tables, parts lists, layout dimensions, material specifications, and other useful information about Dean Brothers centrifugal pumps. It serves to illustrate the interchangeability, adaptability, and modern designs that have been achieved in the design of these pumps.



THE THIEF
is ORGANIC SULFUR

Catalytic removal of objectionable sulfur compounds has been found to work great improvement in the leaded octane numbers of most gasolines. At the same time, "sour" distillates are "sweetened."

FLOREX* and Florite*

are inexpensive natural catalysts which modern refiners use with the most satisfactory results in their desulfurization processes. Samples and technical data are available on request. Inquiries are welcomed.

* Trademark Registered

FLORIDIN COMPANY
ADSORBENTS

Department D, 220 Liberty Street—Warren, Pa.

Notes from France

By RICHARD SNEDDON, *Pacific Coast Editor*

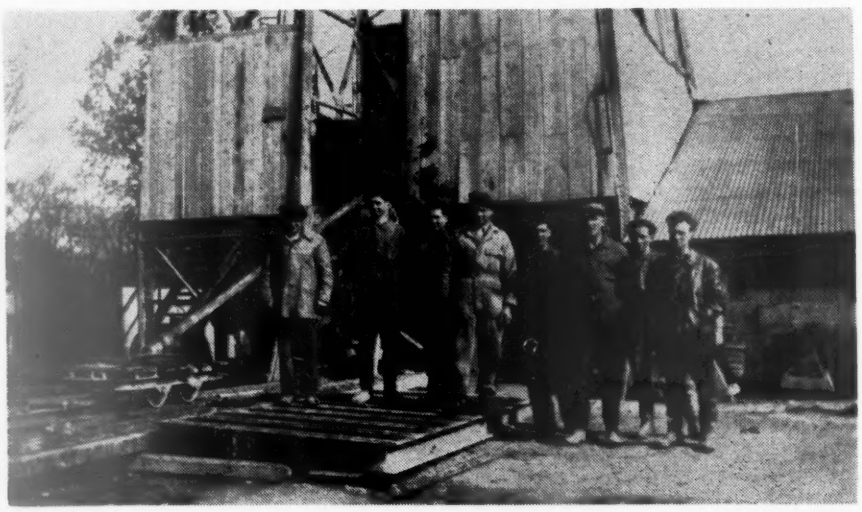
Regie Autonomedes Petroles (RAP) No. 1 Puymaurin at 3550 meters (11,648 ft). This is the deepest well in France.

JUDGING by the number of young Frenchmen who periodically jaunt to the United States these days to amplify their understanding of petroleum operations, France is definitely becoming oil conscious. Of course, we do not wish to imply that the French interest in oil is new. To the contrary, oil reserves as of January 1, 1947, the result of many years of operation, were approximately 9,000,000 bbl; however, there is no question of a new excitement, a much accelerated program of exploration and exploitation, and an increasing anxiety to learn and adopt the devices and techniques of the major producing countries, particularly those of the United States. From our good friend, Ted Lynton, with the Institut Du Pétrole in Paris, we get occasional interesting accounts of what goes on petrolically in the land of the fleur-de-lis. Between these reports and what we are able to garner from our French visitors over here, it is easy to appreciate that France is at this moment engaged in a determined effort to find out just what her oil resources are, and at the same time is equipping herself to develop these resources to the best possible advantage.

EXCLUSIVE

During the last half of June, Ted Lynton spent much of his time in Morocco, setting up the essentials of a drilling school, with experienced Americans as instructors, and using for the practical work a new unit rig of 9500-ft capacity. With this technical direction and modern equipment, inexperienced workers are being quickly qualified to take their places in drilling and production operations. Back in France on July 2, the educational program was notably advanced when Professor L. C. Uren, University of California, (accompanied by Mrs. Uren) arrived and immediately began a daily lecture course on drilling and production methods. Professor Uren had been invited to France by the Institut for two months, and until July 21 delivered his excellent course of instruction to some 60 post graduate students and French engineers from various oil companies. Referring again to the drilling school, it is near Sidi Slimane, and three American drillers, C. C. Buchanan, H. A. Broughton, and Tom Silcox are carrying on the practical instruction with the aid of 18 Frenchmen, mostly college graduates, who have been chosen because of their respective aptitudes for the various jobs involved.

French drilling crew at the SNPA Garlin No. 1 March 11, 1947. There are seven men in the crew with one petroleum engineer in charge.



On July 21 last, Professor Uren, Ted Lynton, and four French engineers, traveled by plane to Morocco and there spent a week looking over the drilling wells, one of which may be the discovery well in a new oil field. At present it is producing only 10 bbl of 35-deg API oil from a tight lime at 4000 ft, but it is in an entirely new area far from established production, and is, thus, most encouraging. Returning to France toward the end of July, the party spent several pleasant days with officials of the Societe Nationale Des Petroles Du Languedoc Mediterranean, examining this company's properties and operations. One of its wells, on a fine structure, has encountered high gas pressure, and looks very promising. Professor and Mrs. Uren were scheduled to sail homeward on the S. S. La Grasse on September 10. Their visit on the "continong" was both pleasant and profitable for the French folk, and the pair were much appreciated ambassadors.

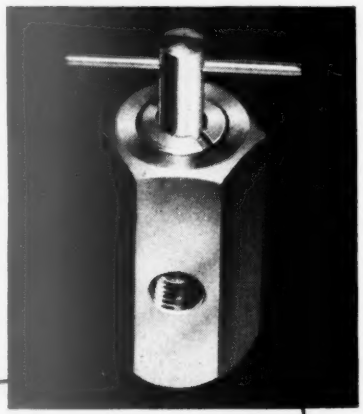
Many other well known American oil

The Byron Jackson Plant at 6247 Navigation Boulevard, Houston

View of Machine Shop

Protect Your Gauges And Recorders From Surging Pressures With The

MARTIN-DECKER PULSATION DAMPER



THE MARTIN-DECKER Pulsation Damper is a pressure gauge damper of proven merit, fully adjustable, easily cleaned, for use in connection with gauges operating under pulsating pressures. It can be used on air, gas, oil, water, steam, gasoline pressure lines, etc. Dampens out slow or rapid pulsations with the smallest possible amount of drag or time lag. Installations can be made in any position desired without affecting efficiency. Quickly pays for itself by protecting gauges and recorders from damaging pressure surges. Operates under pressure of minus 0 to 10,000 lbs.

Write for descriptive literature.

MARTIN DECKER CORP.
LONG BEACH, CALIFORNIA

Outside of restaurant at Lalongue are Desmonts of SN Marep; Bouche, SNPA engineer; Taylor Bannerman of Totco; Bill Goldey, Lucey Export, and the chauffeur.

At the SNPA No. 1 Audignon near St. Sever are Fred W. Dallas, tool pusher; Bill Goldey, Lucey Export; C. C. Buchanan, driller, and Taylor Bannerman, "Totco."

and equipment men have visited in France during the summer, among them, Tom Walne, National Supply Company; Taylor Bannerman, Totco; Bill Goldey, Lucey Export, and Jimmy Harder, Hughes Tool Company, all of whom have been convoyed over the high spots in French oildom and particularly the operations of the Institut Du Petrole, by the ubiquitous Ted Lynton, who, we are told, now talks French so fluently and continuously that he is planning a trip back to the United States to brush up on his American. A very recent tourist from the United States was John Flanagan, service engineer of M. O. Johnston Company, over to instruct the Institut people in the use of the Johnston formation tester. John was accompanied by Nick Kendall, mud engineer of Standard Oil Company of Texas, on loan for several months to the Institut to impart his highly specialized knowledge of the characteristics of mud, and the techniques of mudding operations, to its engineers and drilling crews.

It is interesting to learn that the Standard Oil Company of New Jersey, through its French subsidiary, the Standard Francaise des Petroles, is negotiating as this is written for a large concession in southwestern France. Popular local opinion is that the concession will be granted, as its limits have been freely disclosed in Bordeaux newspapers. The periphery of the concession is as follows:

1°—From La Rochelle (Department of Charente Maritime) north to Cognac (Charente) and thence to Riberac (Dordogne).

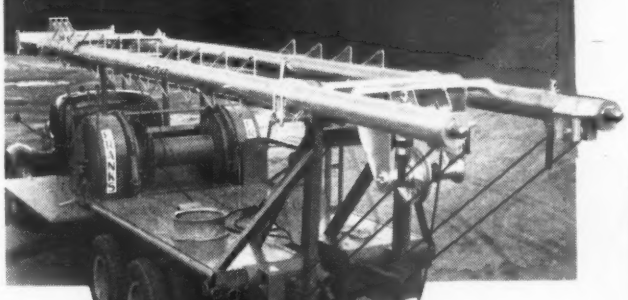
2°—From Riberac east to Casteljaloux (Lot et Garonne).

3°—Thence south to Biscarrosse (Landes).

4°—Thence west in a straight line to the Atlantic shore.

The size of the concession is 1,740,000 hectares, or approximately 4,530,000 acres, and it has been rumored but not officially confirmed that drilling operations must begin within six months after the signing of the agreement. ★★★

How



The known and proved superiority of Franks drawworks and telescoping derrick, combined with the following new features provide the most economical and easy operating servicing unit designed:

"FRANKSAIR" FULL AIR-ACTUATED CLUTCH affords a lighter weight unit, more direct action and maximum ease of operation. Linkage, thrust levers, cranks and virtually all mechanical shifters are eliminated. Gradual engagement at the will of the operator is provided. The retention of clutch mechanism in either engaged or disengaged position is independent of sustained air pressure. As the air actuating mechanism is some distance from the area of clutch engagement, problems of excessive heat on the mechanism are virtually eliminated.

HYDRAULIC TYPE SINGLE POINT ADJUSTMENT CLUTCH, combining four clutch "dogs", inter-connected by high pressure metallic hose, all "dogs" of which are adjusted simultaneously and equally by pressure from a grease gun applied to one Alemite fitting.

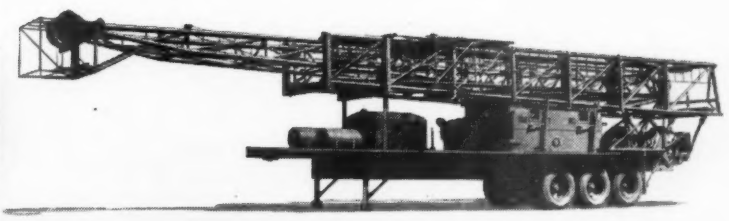
"TELEMECH" AIR CONTROLS. A complete system of air-actuated controllers for all manipulations of shift, brake, and clutch is offered. "Telemech" remote controls is a box, movable to any position and location desired by the operator, permitting operatioa and control of the winch unit, engine, clutch, and brakes at a distance from the well head with the ease of true "fingertip" touch, and with full range of adjustments and speed. This box eliminates blind spots in any derrick.

Available thru Recognized Supply Stores and Franks Sales and Service Branches

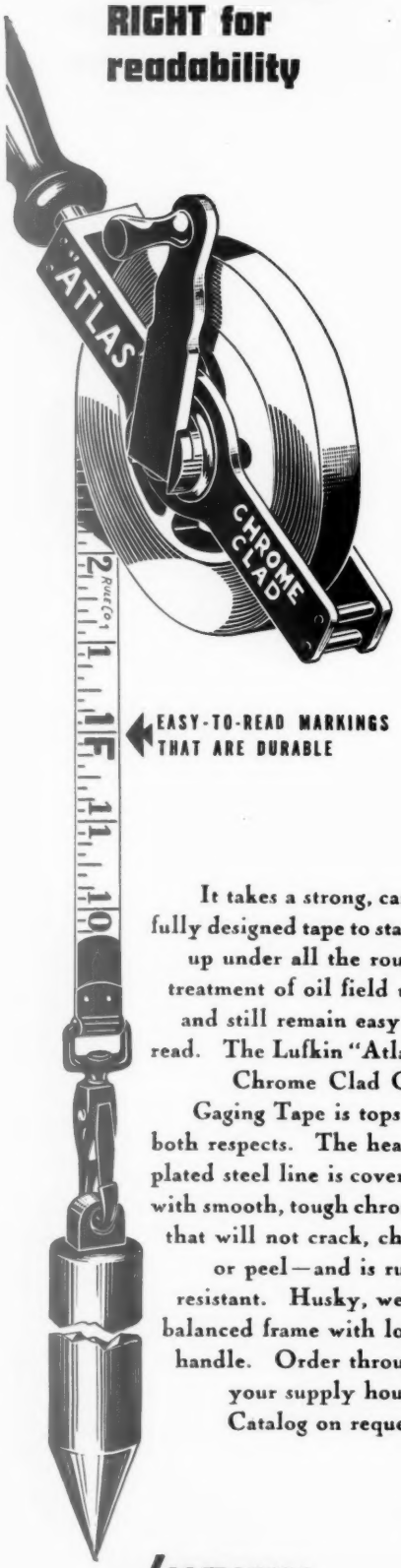
Export Representative: A. V. Simonson, 149 Broadway, New York, N. Y.
Exclusive Pacific Coast Representative: Hillman-Kelley, Inc., 1000 Macy Street, Los Angeles.
Franks Sales and Service Branches: Fort Worth, Houston, Kilgore, Odessa, Great Bend, Mt. Vernon, Compton, Calif.

Plant and Main Office: Dawson Road, Box 3218, Tulsa

FRANKS MFG. CORP.
WELL SERVICING AND DRILLING UNITS



TOPS IN TOUGHNESS, RIGHT for readability



It takes a strong, carefully designed tape to stand up under all the rough treatment of oil field use and still remain easy to read. The Lufkin "Atlas" Chrome Clad Oil Gaging Tape is tops in both respects. The heavy plated steel line is covered with smooth, tough chrome that will not crack, chip, or peel—and is rust-resistant. Husky, well-balanced frame with lock handle. Order through your supply house. Catalog on request.

LUFKIN

THE LUFKIN RULE CO.
SAGINAW, MICHIGAN, New York City

CRUDE, GRADED CRACKED AND VOLATILE

The timid little man and his large dominating spouse breezed into the store seeking a pair of pants for papa. Mama, however, was doing the selecting. On those rare occasions when papa opened his mouth to speak, mama promptly shut him up with the observation: "You don't want that pair. Show us some more, clerk."

At long last the clerk picked up the only remaining pair. "If these aren't satisfactory," he said to papa, resignedly, "we haven't a thing for you. Why don't you try them on?"

The timid hubby dug deep into his practically dry well of matrimonial courage. He tossed the last pair of pants over to his wife. "You try 'em on." he said, acidly.

* * *

"I like the shy, demure type," observed the sailor, "you know—the kind you have to whistle at twice."

* * *

"I think you should be ashamed making passes at me after a half dozen drinks?"

"And why should I be ashamed?"

"For wasting those last five drinks."

* * *

Teacher: Why does a man's hair turn gray quicker than his mustache?

Jimmy: 'Cause it had a twenty year start.

* * *

"The brain of the average college student is the most amazing thing known to science."

"Why?"

"It starts to function the minute he jumps out of bed and doesn't stop until he reaches the classroom."

* * *

At a small town in Kentucky a tourist once called to an old native of the village: "Hey, uncle! How far is it to Lexington?"

"I dunno, mister; hit used to be 'bout 25 miles; but th' way things has gone up around here, may be near 40 by now."

* * *

Ham Bacon (announcing program to group of engineers): We are planning to have a well known engineer address us on the subject of making gasoline from natural gas . . . (audience waits, silently and expectantly) . . . you know, it's a pretty good process that converts something you can blow into something that drips.

* * *

The famous psychologist had just delivered a most interesting lecture, and was now conducting a question session.

A timid little man down front held up his hand, and was recognized.

"Doctor," he said most respectfully, "did I understand you to say that a good poker player could successfully handle any sort of executive job?"

"That's exactly what I said," was the confident reply.

"Tell me, Doctor," asked the little man, "what would a good poker player want with a job?"

* * *

She: And after we are married, will you give me an allowance?

He: Assuredly, dear.

She: A liberal one? So that I may buy anything I like?

He: Of course, darling. You may spend my money just as fast as I make it. Any other question?

She: Yes. How fast can you make it?

* * *

"Philosophers," declared the star optimist of the club, "tell us that the best way to get the most out of life is to fall in love with a great problem or a beautiful woman.

"Well," admitted the Gloomy Gus of the little gathering, "I fell in love with the latter and now I have both!"

* * *

Professor: Didn't you have a brother in this class last year?

Student: No, sir, it was I. I'm taking this course over again.

Prof.: Extraordinary resemblance, though, extraordinary!

* * *

Don't keep telling her you're unworthy of her.

Better let it come as a surprise.

* * *

A young man was patiently waiting in front of the Post Office window behind which two female clerks were busy talking. "Her evening gown," said one, "was of metallic brocade, had a braided bow, and full sleeves." At this point the young man broke in with: "I wonder if you could get me a neat purple stamp with a perforated hem, the whole business treated with a coating of lovely mucilage and costing about three cents?"

* * *

A local salesman was riding downtown with an out-of-state visitor in the visitor's car. They had waited at the stop signal through the red light and for some little time after it had turned green.

Thereupon the salesman remarked, "You may as well drive on; this is the only shade of green we have here."

* * *

Panting and perspiring, two Irishmen on a tandem bicycle at last got to the top of the steep hill.

"That was a stiff climb, Pat," said the first.

"Sure and it was that," said Mike. "And if I hadn't kept the brake on, we would have gone backward."

Now... more efficient than ever...

THE BAKER MODEL "K" CEMENT RETAINER

EQUIPPED WITH

THE BAKER JUNK PUSHER

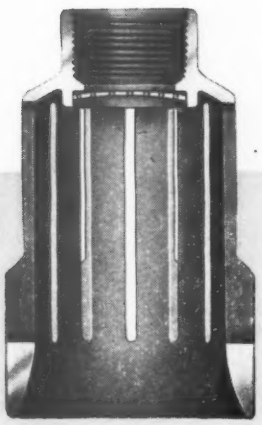
which pushes junk or debris down the hole ahead of the Retainer, and greatly minimizes the hazard of premature tripping of the Retainer by the fouling of the slips.

Use of the BAKER JUNK PUSHER (Product No. 403) assures greater safety and more successful results in . . .

• Re-Cementing • Squeeze Cementing • Cementing behind sections of pipe • Testing upper cased formations • Reducing gas-oil ratios • Cementing bad pipe • Plugging off bottom fluids • Cementing off to perforate for production • Cementing low pressure zones.

EASY DRILLABILITY

Baker MAGNESIUM ALLOY Type Cement Retainers are readily drilled up by using drill pipe, tubing, or cable tools, since all large parts are made of magnesium except the nitricastiron slips which are easily broken up. Magnesium Retainers have ample strength to withstand any pressure which can be imposed safely upon the casing or liner. Although Baker MAGNESIUM ALLOY Type Cement Retainers are satisfactory for *temporary* bridge plugs, they may be affected by well fluids, and the CAST IRON Type is recommended for *permanent* bridge plug installations.



The Baker Junk Pusher has an outside diameter slightly smaller than the inside diameter of the casing in which the Retainer is run. All debris tends to collect in the Junk Pusher. Slots permit passage of displaced fluid, but prevent passage of junk or debris which might foul the slips and result in premature tripping of the Retainer. The internal Screen (held in place by friction) prevents debris from entering the body of the Retainer, and is blown out at the proper time by the Tripping Ball Seat.

BAKER
OIL TOOLS, INC.
Houston - Los Angeles - New York

running tour with men in the industry

● **Jack Clarke,** assistant to the president of Lion Oil Company, El Dorado, Arkansas, has been elected to the oil industry's public relations operating committee, according to Franklyn Waltman, of the Sun Oil Company, Philadelphia, chairman of the committee.

● **W. Howard Pape,** vice president of the Jarecki Manufacturing Company in charge of the oil field supply division, has returned to his Houston, Texas, headquarters from a combination business and vacation trip to several Latin American points. His trip, taken by air, included several cities in Guatemala and Mexico, including Mexico City. He was accompanied by Mrs. Pape.

W. Howard Pape

● **M. MacIver** has been elected vice president of California Texas Oil Company, Ltd., in charge of fiscal matters, succeeding **William Kunstadter,** former vice president and treasurer, who died of a heart attack earlier this year. MacIver joined the Caltex organization as general auditor in 1938, after many years' experience in the petroleum industry as accountant on pipe line and refinery construction, and general auditor in companies affiliated with Caltex. He was appointed comptroller in 1946.

● **Arthur Nikand** has been appointed factory manager of the Portland plant of the Hyster Company, manufacturers of lift and straddle trucks and tractor-mounted construction equipment, **Eugene Caldwell,** general manager, announced. Nikand was first employed as a machinist at Hyster in 1934 after working in a similar position for Willamette Iron and Steel Company, Portland, for ten years. He was appointed foreman of hoist equipment assembly in 1938, and assistant factory manager the next year, a position he filled until assuming the new position, October 15.

● **James W. Hammond,** formerly chief industrial hygienist and assistant director for the division of industrial hygiene of the Georgia State Department of Public Health, has been added to the medical division staff of Humble Oil and Refining Company as industrial hygiene engineer. Hammond will direct an expanded program of industrial hygiene mapped out by the Humble companies. His work will deal primarily with working conditions of employes where any factors relating to their health are involved, and he will act in an advisory capacity with Humble's civil engineering department in connection with sanitary codes, water supply, and living conditions of employes in pipe line and production field communities and at Baytown.

● **Clyde Williams,** president of the American Institute of Mining and Metallurgical Engineers, at the dinner of the Metals Divisions, announced that the Charles F. Rand Gold Medal had been awarded by unanimous vote of the board of directors to **Eugene Gifford Grace,** chairman of the board, Bethlehem Steel Corporation, for "distinguished achievement in mining administration".

● **Jerry Bowen,** Western Gulf Oil Company, has been appointed general chairman of the American Petroleum Institute 1948 spring meeting to be held in Los Angeles next May 6-7, according to announcement by E. V. Watts of General Petroleum, Pacific Coast chairman of API's division of production. Bowen reports that committees to handle the event are now being formed, with names to be announced in a few weeks.

● **E. Charles Patton, Jr.,** petroleum engineer, Magnolia Petroleum Company, Dallas, Texas, is the 1948 recipient of the Raymond Memorial Award of the American Institute of Mining and Metallurgical Engineers. The award is made annually to the author whose technical paper is the outstanding original contribution of both scientific and practical value. The competition is restricted to authors under 33 years of age and includes papers on mining and metallurgy as well as petroleum production. Patton, who is a native of Dallas, an ex-student at Southern Methodist University, and a graduate of the University of Texas, will receive the award at the Institute's Annual Meeting in New York in February. His paper is entitled "Evaluation of Pressure Maintenance by Internal Gas Injection in Volumetrically Controlled Reservoirs."

E. Charles Patton, Jr.

● **Nolan B. Sommer** has recently joined the sales department of Jefferson Chemical Company, Inc., as market development representative. Dr. Sommer was previously a research chemist in the Stamford laboratories of the American Cyanamid Company.

● **Edwin C. Paige** has been named head of the Fleet Section of its technical service division by Ethyl Corporation. The technical service division, which functions as part of the Ethyl Research Laboratories in Detroit, serves as a liaison group between the Laboratories and the petroleum, automotive, and agricultural machinery industries. Paige succeeds **Errol J. Gay,** who has resigned from Ethyl Corporation to open a Detroit office as private consultant to petroleum and automotive companies on problems relating to engines, fuels, and lubricants.

● **Dan Fore, Jr.,** has joined the research department staff of Phillips Petroleum Company in Bartlesville, Oklahoma. Dr. Fore, a native of Mississippi, did his undergraduate work at Mississippi College located in Clinton, Mississippi, and obtained his Ph.D. in chemistry from the University of North Carolina. He joins Phillips from the Naval Research Laboratory in Washington, D. C., where he has conducted and directed research on fuels for Navy use.

Dan Fore, Jr.

● **C. G. Kirkbride,** manager of Houdry Laboratories, has announced the appointment of **Dr. Alex G. Oblad** and **Jack C. Dart** as director of chemical research and director of development, respectively. The new men will make their headquarters at the Houdry Laboratories near Marcus Hook, Pennsylvania. Dr. Oblad is an outstanding chemist with broad experience in the petroleum industry. He has worked chiefly in the fields of hydrocarbon catalysis, chemical thermodynamics of hydrocarbons and physical methods of analysis. He was graduated from the University of Utah and obtained his doctor's degree in physical chemistry from the University. His professional career includes work in the research department of Standard Oil Company (Indiana); the field of research department, Magnolia Petroleum Company, where he became chief of chemical research; and later as head of industrial research for the Texas State Research Foundation at Dallas.

J. C. Dart

Alex G. Oblad

Jack C. Dart is likewise a well-experienced man in all phases of petroleum development. His academic training includes an A.B. degree from Albion College. His studies in chemical engineering were continued at the University of Michigan where he received his bachelor's and master's degrees in chemical engineering. His professional career includes employment with Pan-American Refining Corporation, Magnolia Refining Corporation, Magnolia Petroleum Corporation, and Standard Oil Development.

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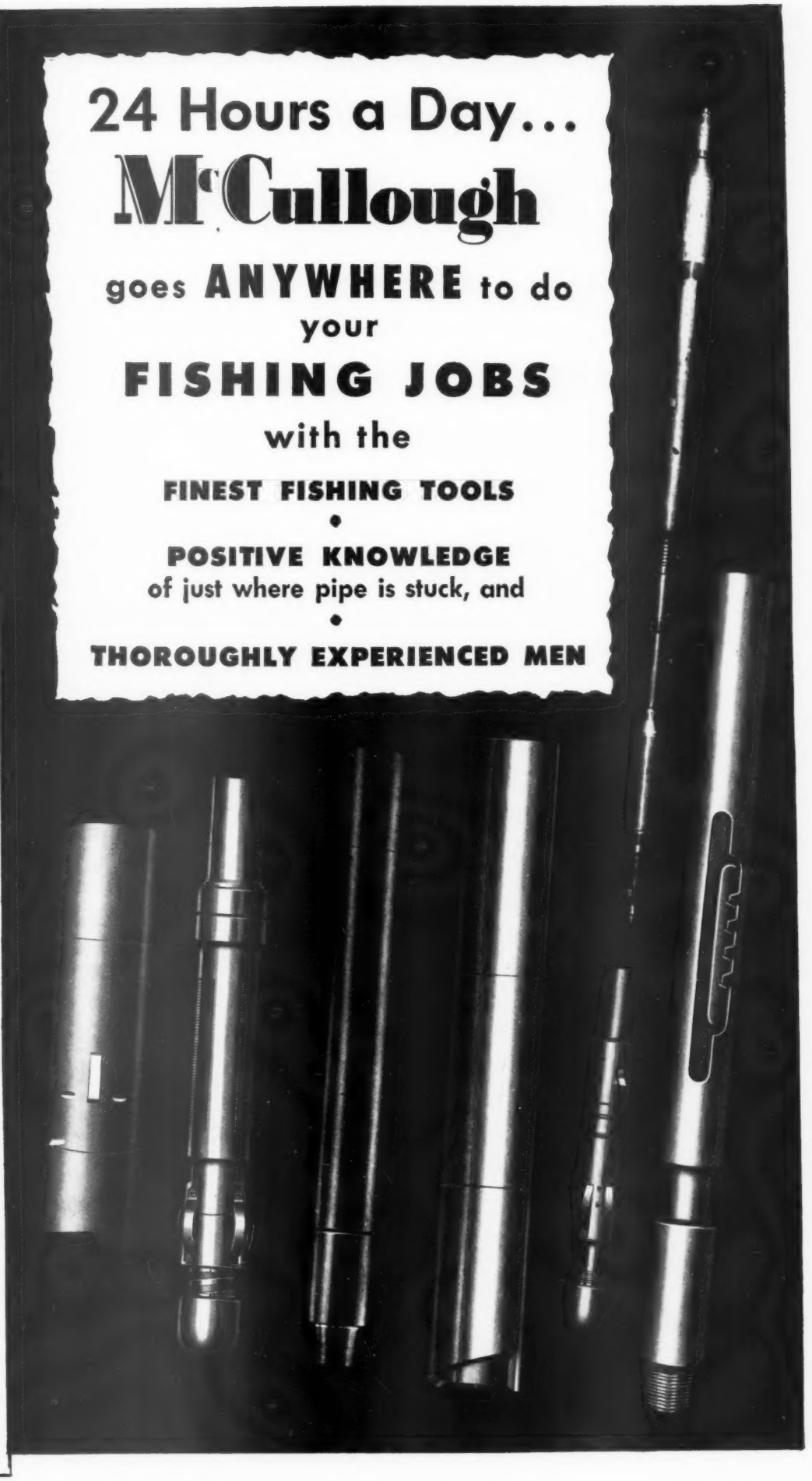

● **Robert L. Martin** of Tulsa, Oklahoma, a junior at the Missouri School of Mines, Rolla, has been awarded the American Institute of Chemical Engineers national scholarship for maintaining the highest scholastic average in the chemical engineering department during his freshman and sophomore years.

● **Hearn J. Paschall,** sales and service engineer of the H. C. Smith Oil Tool Company, is now in the Middle East where he is making an extensive tour of the various oil fields throughout that area. Paschall is making his headquarters at Cairo and will be the exclusive representative for the H. C. Smith Oil Tool's in the Middle East.

H. J. Paschall

● **Franklin W. Bates** has been appointed West Coast counsel for the Arabian American Oil Company and Trans-Arabian Pipe Line Company. Bates has been associated since 1937 with the San Francisco law firm of Pillsbury, Madison and Sutro, whose clients include the Standard Oil Company of California, one of the parent companies of Aramco and Tapline.

● **J. M. Taylor,** who has been district manager for the American Iron and Machine Works Company at Houston, Texas, is being transferred to the home office in Oklahoma City and will function as a special representative. Taylor will be succeeded by **Bryan Curtis** as district manager at Houston.

J. M. Taylor

● **Frederick H. Foglesong** has been appointed to the staff of the Detroit district sales office of The Babcock and Wilcox Tube Company. Prior to this connection with the B & W Tube Company, Foglesong was with the steel and tube division of the Timken Roller Bearing Company in the Detroit office. He is a graduate of Michigan State College, where he majored in chemistry, and was graduated from the University of Michigan with a degree in metallurgical engineering.

● **W. L. Martin,** who has represented the American Iron and Machine Works Company for the last eight years in Illinois, Indiana, and Kentucky, has been transferred to Oklahoma City to take charge of the rental yard. He will be succeeded by **B. E. Sharp,** who was previously chief inspector and connected with the engineering department in the Oklahoma City office.

● **J. Walter Leonard** has been elevated from president to chairman of the board by the Leonard Pipe Line Company and **David Beach** has been promoted from executive vice president to president.

● **Arthur F. Bridge,** who has been vice president and general manager of the Southern Counties Gas Company since 1939, has been elected president and general manager. **F. S. Wade,** who has served in a dual capacity since 1939 as president of both Southern California Gas Company and Southern Counties Gas Company, retired from his position in the latter organization. **Guy W. Wadsworth** was elected a member of the board of directors and vice president and assistant general manager of Southern Counties Gas Company. Wadsworth, who was formerly a director and vice president in charge of employe relations for the Southern California Gas Company is resigning his post with that company. Wadsworth has been employed by the company, with interruptions due to military and other service, since 1921. Latterly he has served the company as vice president in charge of employe relations. **F. A. Hough,** present executive engineer and a director of Southern Counties Gas Company, is made a vice president. Wade, who has been with Southern Counties Gas Company since 1912, retains his connection with the organization as a member of the board of directors. He continues as president and general manager of the Southern California Gas Company, which is affiliated with Southern Counties Gas Company through Pacific Lighting Corporation.

● **Gene Loper,** assistant to Henry McMasters, Union Oil Company's salvage department head, left November 3 for Paraguay, South America, where for the next two years he will be employed as supervisor of supplies and materials. Gene has been with Union Oil Company for 18 years and has been a popular member of the Santa Fe Springs group. He travels via Mexico City; Balboa, Canal Zone; Guayaquil, Ecuador; Lima, Peru; Antofagasta, Chile; Santiago, Chile; thence over the Andes passes to Buenos Aires; by river boat to Asuncion, Paraguay, and finally by plane again to the Chaco.

● **D. E. Carr** has joined the research department of Phillips Petroleum Company at Bartlesville, Oklahoma, as a consultant on lubricants. For a number of years he has been with the Union Oil Company as director of research. Carr is a native of California and received his scientific education at the University of California, College of Chemistry. He has been particularly identified with the pioneer work on propane dewaxing and deasphalting, contributing a number of papers and patents in this field. He has also been directly connected with recent technical advances in the refining and utilization of petroleum waxes and has directed a continuously active program on the development of lubricating oil additives.

D. E. Carr

● **C. L. Braswell** has been transferred to Hobbs, New Mexico, by The American Iron and Machine Works Company to better serve the West Texas and New Mexico area. Braswell previously was city sales representative in Houston, Texas, and will be succeeded by **R. A. Feemster.**

C. L. Braswell

● **George Miller,** president of Oil Base, Inc., Compton, California, makers of Black Magic oil base drilling fluid, recently attended the AIME Convention in Tulsa, Oklahoma. The company's novel display created much comment. Miller visited Oklahoma City, Dallas, Fort Worth, and Houston, making a short stay at each of the company's branch offices. At St. Louis he inspected special equipment being built for the new Oil Base, Inc., plant in Compton, California. He returned to California late in October.

● **R. B. Scott** has been appointed general accountant, United States Steel Corporation of Delaware. Scott succeeds **S. P. Smail,** who has been elected comptroller and a director of the American Bridge Company.

● **A. Lynn Porter** has joined Tennessee Gas Transmission Company as internal auditor. He was formerly with Magnolia Petroleum Company of Beaumont, Frazier and Torbet in Houston, and Boney and Porter in Houston.

● **E. W. Deck,** formerly general manager of the Trent Tube Manufacturing Company at East Troy, Wisconsin, and a wartime administrative official for the Manhattan Project, has become manager of the Ithaca plant of the Morse Chain Company, a division of Borg-Warner Corporation.

● **S. J. Stacey** was recently appointed comptroller of the California Texas Oil Company, Ltd., succeeding **M. MacIver,** who was elected vice president in charge of fiscal matters. Stacey was born in New York City on May 8, 1910, and is a graduate of the College of the City of New York. He joined The Texas Company on February 1, 1927, and was transferred to California Texas Oil Company, Ltd., on July 1, 1936, upon the organization of that company. Stacey has held the positions of chief accountant and assistant comptroller in California Texas Oil Company, Ltd.

● **William H. Meyer, Jr.,** has been named director of the recently organized photogrammetric division of Lockwood, Kessler & Bartlett, Inc., engineers, Brooklyn, New York. Meyer (B. A. Columbia 1921) whose experience in photogrammetry began in 1927 with Fairchild Aerial Surveys, Inc., New York, was general manager of their eastern division from 1935 to 1940. In 1940 he went to Aero Service Corporation, Philadelphia, where as vice president he was responsibe for promotion and direction of photogrammetric projects.

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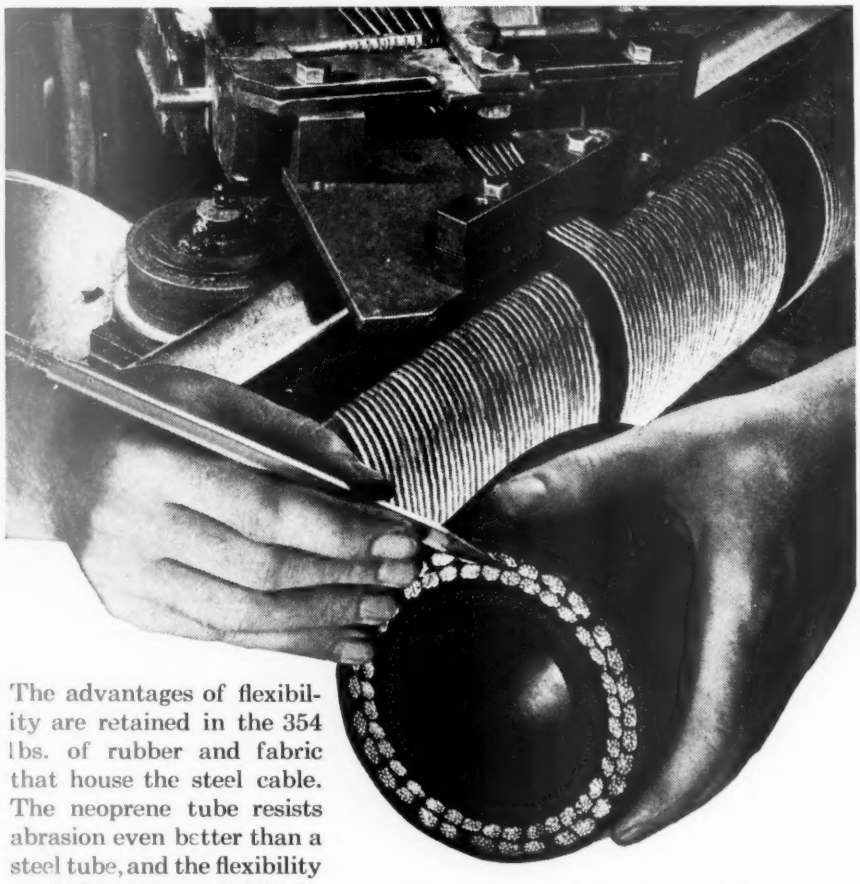

The advantages of flexibility are retained in the 354 lbs. of rubber and fabric that house the steel cable. The neoprene tube resists abrasion even better than a steel tube, and the flexibility needed for rotary work is obtained in a single, unbroken, free-flowing length of hose.

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● **R. M. Morrison,** general purchasing agent of The Texas Company since 1944, has been appointed manager of the purchasing department, it was announced by **Harry T. Klein,** president. He succeeds **R. S. Hatch,** who goes to Arabian American Oil Company. **Philip Hauck** succeeds Morrison as general purchasing agent. **W. G. Taylor** replaced Hauck as divisional purchasing agent at Chicago, and **F. G. Schlemmer,** Los Angeles, becomes northern divisional purchasing agent at New York to succeed Taylor. **M. E. Hankins** replaces Schlemmer as assistant purchasing agent at Los Angeles.

Morrison entered the oil business in 1914 as roustabout for Montebello Oil Company, Fillmore, California. Later he was employed by Tay Pike Oilwell Supply Company and Ventura Refining Company, Los Angeles. In 1926 he became buyer and assistant purchasing agent of California Petroleum Corporation, retaining that position when Calpet was acquired by Texaco. In 1939 he went to New York as purchasing agent and became general purchasing agent in 1944.

● **Francis A. Paquin** has been appointed chief tool engineer of Sier-Bath Gear and Pump Company, Inc., North Bergen, New Jersey. Paquin was formerly chief tool designer for Wright Aeronautical Corporation and, before that, was with Brown and Sharpe Manufacturing Company.

● **Ray Sanders,** identified with the industrial chemical field for the last 25 years, has been appointed general manager of the Pacific Chemical Company, Los Angeles, a division of the American-Marietta Company.

● **E. W. Berlin,** of 4 Forest Lane, Scarsdale, New York, has been named head of the producing department of Standard-Vacuum Oil Company. He succeeds **H. W. McCobb** who recently was elected to the board of directors. Berlin was born in Sistersville, West Virginia, and was reared in Tulsa, Oklahoma. He was graduated from the University of California at Berkeley with a B. S. in petroleum engineering in 1926.

● **Donald F. Greenlaw** has been appointed Oil Well Supply Company representative to serve the Corpus Christi, Texas, area. Greenlaw, who has been transferred from San Antonio to Corpus Christi, was a captain in the Army Air Forces in World War II. He joined "Oilwell" in December, 1945, and served in stores at Alice, Texas, and Pettus, Texas, until January 1, 1947, when he transferred to the company's Oil City plant for a student engineering training course. He completed this course July 1, 1947, subsequent to moving to San Antonio as city representative.

● **Dale W. Patrick,** of the Jones and Laughlin Steel Corporation, metallurgical department, has joined the personnel of the Pittsburgh Screw and Bolt Corporation, Colona division. Patrick spent several years at both the Aliquippa and Oil City plants of Jones and Laughlin in the inspection, production, and metallurgical departments.

Jarecki appointments

The Jarecki Manufacturing Company has announced three important appointments to its oil field supply staff.

Joseph P. Branch has been appointed district manager in South Texas with headquarters at the company's Corpus Christi store. Branch has a background of 20 years in the oil field supply business and is particularly well known in the Southwest Texas area, where he has been for the last 12 years.

W. B. Reynolds has been appointed manager of industrial sales for the South Texas area, also with headquarters at Corpus Christi. Reynolds is also widely known in the Southwest Texas oil industry. He has been engaged in the oil field supply business for the last 10 years and has been active in the Southwest Texas area since 1943.

Sam T. Dyer has been appointed special sales representative for the Jarecki Manufacturing Company with headquarters at the main office of the company's oil field supply division at Houston. Dyer has been active in the oil industry, particularly in the Texas Gulf Coast area since his graduation from college in 1929, his experience including work in the oil fields as roustabout and roughneck, followed by extensive experience in selling oil field equipment. He is also well known in the field of sports, being one of four brothers all of whom have been prominent in baseball and other sports activities.

Joins Wheatley

M. J. "Tiny" Bridges has joined the sales organization of Frank Wheatley Pump and Valve Manufacturers as district sales manager of Texas, according to an announcement by Frank Wheatley, Jr., vice president-general manager of the firm.

Bridges will have his headquarters in Fort Worth, Texas. He was formerly with the Midco Valve Company, joining that firm with 12 years' experience as a representative of the Iverson Tool Company.

Dallas Geophysical Society organized

The Dallas (Texas) Geophysical Society was organized on October 1 at a meeting attended by a large group of geophysicists and others interested in geophysics. A. E. McKay was acting chairman and W. W. Newton acting secretary-treasurer. A committee to draft a constitution and by-laws was appointed. This committee consisted of W. W. Newton, The Geotechnical Corporation, chairman; K. E. Berg, Geophysical Service, Inc.; Paul E. Nash, Magnolia Petroleum Company, and A. E. McKay, Atlantic Refining Company.

The first regular monthly meeting was held November 4 at Fondren Library Auditorium on the Southern Methodist University campus, with an attendance of 88.

The constitution and by-laws were adopted and charter members were signed. Permanent officers for the coming year were elected from a slate prepared by Henry C. Cortes and Cecil H. Green, past president and president, respectively, of the Society of Exploration Geophysicists. A. E. McKay of Atlantic Refining Company was elected president; W. W. Newton of Geotechnical Corporation, first vice president; C. J. Donnally of Western Geophysical Company, second vice president, and D. Ray Dobyns of the Magnolia Petroleum Company, secretary-treasurer.

Following the business session Paul E. Nash presented a paper on "A Resume of Efforts to Promulgate Rules and Regulations Governing Offshore Seismic Exploration on the Texas Gulf Coast." Kenneth Berg presented a paper on "Seismic Operations and Offshore Operations on the California Coast."

Meetings are to be held monthly and the membership is open to all persons interested in the science of geophysics, including students. The purpose of the organization is to promote further the science of geophysics by the presentation of papers at monthly meetings and to promote fellowship and cooperation among those persons interested in geophysical problems.

The Dallas Geophysical Society will petition for affiliation as a local section of the Society of Exploration Geophysicists.

Dallas Geophysical Society officers: W. W. Newton, first vice president; A. E. McKay, president, and D. Ray Dobyns, secretary-treasurer. Absent, Chester J. Donnally, second vice president.

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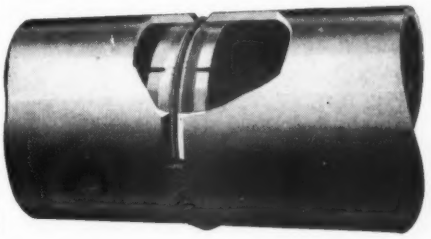

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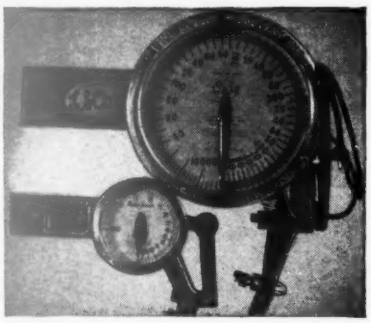

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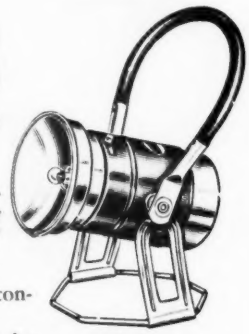

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Assistant sales manager

Cameron Iron Works, Houston, Texas, has announced the appointment of R. F. (Bob) Farmer as assistant sales manager. Farmer is well known throughout the Gulf Coast and Mid-Continent where he has been identified with the oil tool supply and manufacturing industry for the last ten years. He joined the Cameron sales department in 1942, working as salesman in the Houston territory and later was transferred to Corpus Christi. In 1944 he was sent to Tulsa as Mid-Continent division manager. It was from that position that he was promoted to assistant sales manager on September 1, returning to the company's Houston headquarters.

R. F. Farmer

R. W. Gustine, formerly Cameron sales representative at Shreveport, Louisiana, has been transferred to Tulsa to assume the position held by Farmer. Gustine will make his headquarters at 310 Thompson Building, Tulsa.

Unibolt changes

Thornhill-Craver Company, Houston, Texas, manufacturers of Unibolt products, has announced the following personnel changes: Jay Hembree, who has served as salesman for the company in West Texas for the last two years, has been transferred to Corpus Christi in a similar capacity. Earl Grissom, former sales representative in the Corpus Christi area, was transferred to Oklahoma last month.

Bill Walmsley

Jay Hembree

Bill Walmsley is a newcomer to the Unibolt sales staff. Prior to joining the company Walmsley was a scout for a major oil company in West Texas, where he will continue to operate as Unibolt sales representative with headquarters at Midland.

Medals distributed

Victory and National Defense medals were distributed to some 3000 eligible Allis-Chalmers employes in the Milwaukee area—probably the largest single group in Wisconsin—October 29, 30, and 31 at the company's club house in the army's first public distribution of such medals in the area.

The program was arranged by Major Frank E. Green, commander of the Milwaukee recruiting area, in cooperation with Allis-Chalmers and Allis-Chalmers post No. 500 of the American Legion. Other veterans groups were invited to participate in helping to distribute the medals to an additional 5000 eligible veterans residing in the area.

New department

The Fluor Corporation, Ltd., announces, beginning November 3, the establishment of a Customer Service Department to handle the servicing of its various products of manufactured equipment. E. L. Bishop, who has been employed by Fluor for 12 years in the manufacturing department, will be in charge of this service for the Mid-Continent area, which will be in Houston, Texas. It is believed that the establishment of such a department to take care of service work, start-ups, and any operating troubles that might be encountered, will enable Fluor to render a more complete service to its various clients, it is stated.

E. L. Bishop

Durametallic birthday

Durametallic Corporation, Kalamazoo, Michigan, is this year observing its thirtieth anniversary. The October issue of "The Stuffing Box", company house organ, is the birthday number and in it is reviewed some of the policies and accomplishments of this firm in the field of metallic packing and mechanical seal manufacture.

"The Packing That Is Engineered for the Job" was a policy of this company long before an advertising man turned it into a slogan, it is pointed out. One of the first steps taken in preparing for the manufacture of Durametallic packings was to set up a test and development laboratory. It was the combined vision of the company's founder, the late Charles C. Hall, the production experience of the company's president, S. A. Schaeffer, and the engineering ability of the founder's son, Richard D. Hall, that established this policy of developing packings to meet specific needs.

Given award

The Hughes Tool Company, Houston, Texas, has received a safety award from the Steel Founders' Society of America following a national safety contest sponsored by the society's safety committee. The award was presented to M. W. Williams, Hughes Tool foundry manager, at the fall meeting of the society at the Wardham Park Hotel, Washington, D. C.

The Hughes Tool Company Foundry was awarded a plaque as the winner in its size group for the period of the contest. According to Williams, the Hughes Foundry did not have a single accident during the period of the contest and for almost three months previously.

New store

The Continental Supply Company has announced the opening of a new store at El Campo, Texas. This store is under the management of D. F. Bell, formerly manager of the Raymondville, Texas, branch. This point is under the supervision of W. G. Fitzpatrick, district manager, Houston.

G. W. Patterson has assumed management of the Raymondville store, being transferred from the store at Falfurrias, Texas, where he served in the same capacity. George M. Edge, formerly floorman at Falfurrias, has been named manager there.

Program committee

B. J. Dowd, chairman of the A.P.I. Southwestern District, Division of Production, has appointed the following program committee for the spring meeting to be held in San Antonio in The Plaza Hotel on April 14, 15, 16, 1948:

Chairman: R. E. Bridges, Humble Oil and Refining Company, Houston, Texas; T. H. Dwyer, Shell Oil Company, Inc., Midland, Texas; W. F. Eiting, Jr., The Carter Oil Company, Shreveport, Louisiana; W. F. Herbert, The Texas Company, Houston, Texas; H. M. McClain, Magnolia Petroleum Company, Dallas, Texas, and R. B. Saxe, Gulf Oil Corporation, Odessa, Texas.

THE PETROLEUM ENGINEER

Published monthly at Dallas, Texas for October 1, 1947.

State of Texas, County of Dallas, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared W. T. Bryan, who, having been duly sworn according to law, deposes and says that he is the Business Manager of

THE PETROLEUM ENGINEER

and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, as amended by the Act of March 3, 1933, embodied in section 527, Postal Laws and Regulations, to-wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher: The Petroleum Engineer Publishing Co., P.O. Box 1589, Dallas, Texas.

Editor: K. C. Sclater, P.O. Box 1589, Dallas, Texas.

Managing Editor: F. H. Love, P. O. Box 1589, Dallas, Texas.

Business Manager: W. T. Bryan, P. O. Box 1589, Dallas, Texas.

Advertising Manager: T. J. Crowley, P. O. Box 1589, Dallas, Texas.

2. That the owner is a partnership composed of W.T. Bryan, T. J. Crowley, W. L. Love and K. C. Sclater, all of Dallas, Texas, doing business under the name of The Petroleum Engineer Publishing Company.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

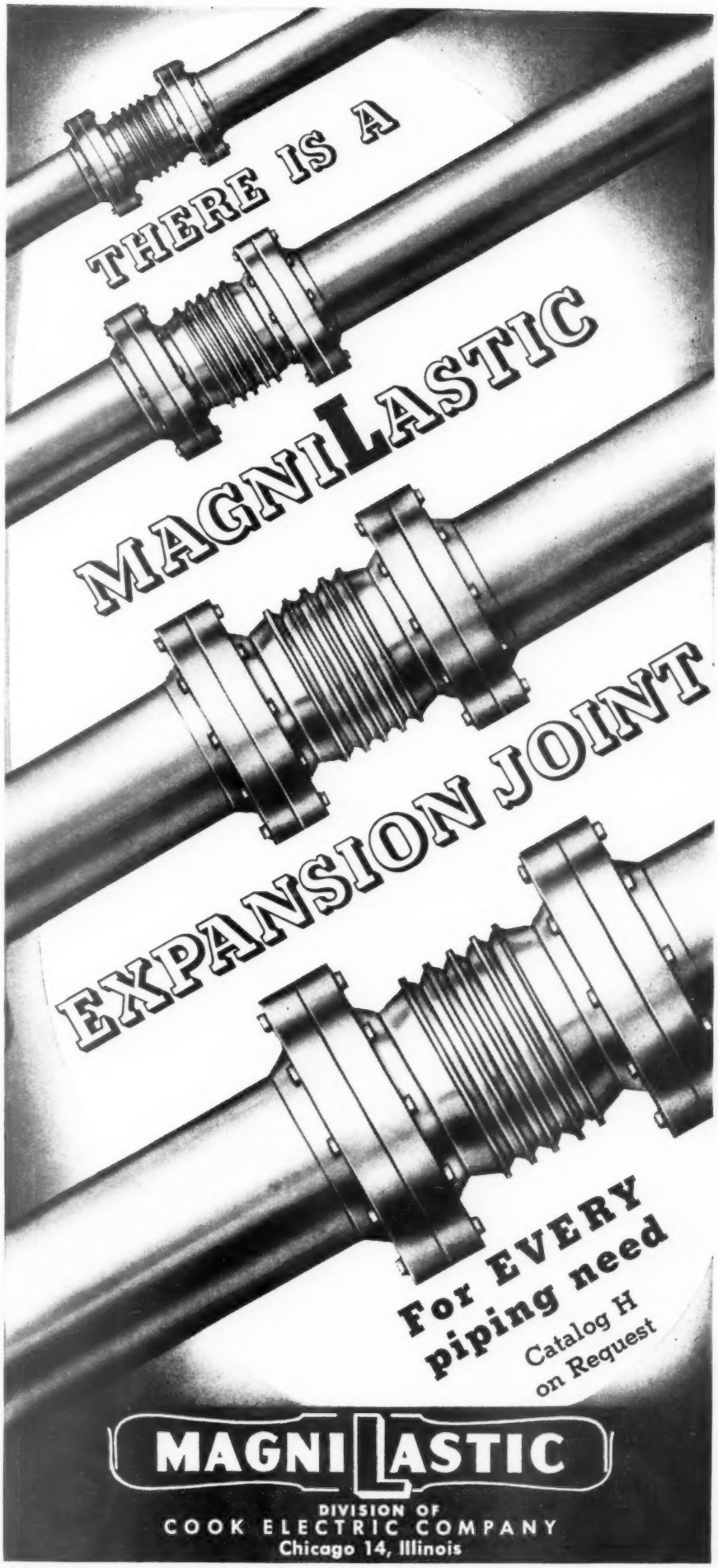
4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has an interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

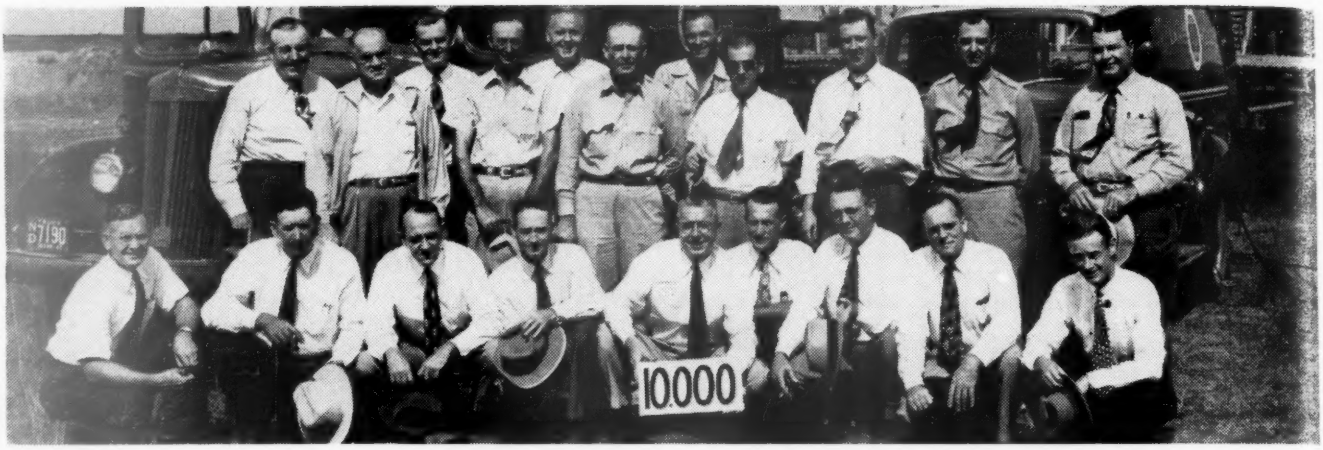
W. T. Bryan, Business Manager.

Sworn to and subscribed before me this 29th day of September, 1947.

[Seal] Lillian H. Johnston

(My commission expires June 30, 1949)





Group that observed 10,000th radioactivity log. Standing: Rodney S. Durkee, president, Lane-Wells Company; John B. Goodrich, division production superintendent, Magnolia Petroleum Company; C. F. Ludwig, Gulf Coast division sales manager, Lane-Wells; George Faulks, farm boss, Magnolia Petroleum Company; Jas. D. Hughes, general sales manager, Lane-Wells Company; T. M. Melton, tool pusher, Magnolia Petroleum Company; C. B. Mitcham, hoist operator, Lane-Wells; Bill Green, president, Well Surveys, Inc.; R. B. McCullar, Mid-Continent division manager, Lane-Wells Company; R. B. Downing, Mid-Continent division sales manager, Lane-Wells Company; H. D. Vaughan, salesman, Lane-Wells Company; in order squatting: Charlie Duller, vice-president, Well Surveys, Inc.; Clyde Turner, farm boss, Magnolia Petroleum Company; Phil Jennings, district geologist, Magnolia Petroleum Company; Phil Davis, petroleum engineer, Magnolia Petroleum Company; R. M. Rutledge, Jr., assistant division sales manager, Gulf Coast division, Lane-Wells; Joe Myers, radioactivity operator, Lane-Wells Company; John J. Neale, Gulf Coast division manager, Lane-Wells Company; Warren J. Jackson, petroleum engineer, Lane-Wells Company; John L. P. Campbell, division geologist, Lane-Wells Company.

10,000th radioactivity log

Magnolia Petroleum Company A-246 Well in Jackson County, Texas, was the location of the 10,000th radioactivity well log run by Lane-Wells Company. Officials of both Magnolia Petroleum Company and Lane-Wells Company gathered at the well October 24 to celebrate the occasion as a milestone in the progress of technical oil field services.

Originally developed by Well Surveys, Incorporated, and operated by Lane-Wells Company under exclusive license, the radioactivity survey utilizes a natural phenomenon of gamma radiation of the various sediments to provide the oil operator with a continuous graphic curve that, upon interpretation, reveals the stratigraphy of the subsurface in either open or cased holes. Having been operated by Lane-Wells Company for the last seven years, it has become extremely useful in this vast industry of production and development to find sandstones and limestones that are potential oil reservoirs, and which can be perforated and tested for commercial production.

Measuring minute quantities of current, the cased hole survey records these currents with two instruments. The gamma ray instrument is a subsurface tool measuring gamma rays to define the various formations from bottom of the hole to the surface level. Complementing this curve, the neutron instrument bombards

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the formations and measures the reaction upon the various layers. Together, these two curves present the only available cased hole log that is useful to the oil and gas industry in correcting, confirming, or finding formations favorable to the accumulation of commercial quantities of oil and gas according to Lane-Wells Company officials.

McCool general manager

The American Iron and Machine Works Company, Oklahoma City, Oklahoma, has announced the resignation of Earl W. Miller as general manager, effective October 1. He is being succeeded by M. G. McCool as executive vice president and general manager. McCool has been with the company more than 12 years. He was originally district manager in 1940, a position he occupied until the recent appointment.

M. G. McCool

Lindenmuth appointed

H. S. Lindenmuth, Larkin Packer Company, Inc., sales representative in Kansas, has been appointed division manager for the northern sales division of Larkin, T. E. Alexander, sales manager, has announced. The northern territory includes the Texas Panhandle, Oklahoma, Kansas, Illinois, Michigan, Kentucky, and Indiana. Lindenmuth will continue to make his headquarters in Wichita, Kansas.

H. S. Lindenmuth

Lindenmuth joined the Larkin sales organization 13 years ago and has worked the Oklahoma-Kansas area as sales representative during these years.

Representative moves

Announcement is made that Schloss and Shubart, 43-year-old engineering and sales organization, marketing power transmission, conveying, and mechanical handling devices throughout the Rocky Mountain region, have moved from the Boston Building, Denver, to 1626 Wazee Street, Denver 2. The telephone remains the same, MAin 0231-2.

The new location comprises 20,000 sq ft of floor space in a five-story building that was formerly occupied by the U. S. Treasury Department, Procurement Division.

Stocks of popular standard Link-Belt products will be carried at the new address, to permit rendering a complete on-the-scene warehouse service. In other words, Schloss and Shubart have been appointed stock-carrying distributors in addition to continuing as Link-Belt sales representatives.

Pump sales manager

J. C. Gorman, president of the Gorman-Rupp Company, pump manufacturers, announces the appointment of H. W. Vine as manager of industrial sales. Vine will direct Gorman-Rupp's sales program in the industrial field.

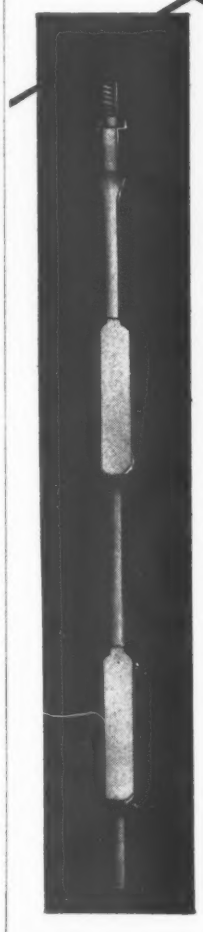
Vine's career in the industrial pump field has been highlighted by sales executive positions he has held with Fairbanks-Morse and Company as sales engineer for a period of 31 years, and the Weinman Pump Company, Columbus, Ohio, as sales manager for 12 years, and for the past year as general sales manager of the Carver Pump Company, Muscatine, Iowa.

Sales manager

Gerald J. Klopfenstein has been appointed sales manager, Meter Division, of Bowser, Inc., Fort Wayne, Indiana, effective November 1, according to an announcement by Fred S. Ehrman, general sales manager.

Klopfenstein joined the organization in October, 1923, and since that time has served in the inspection, production engineering, drafting, designing, and engineering departments. Prior to his new assignment he was manager of planning and sales engineering. As sales engineer during the last eight years he has worked closely with field salesmen and customers on all types of installations.

Look AT THE SAVINGS YOU MAKE with HUBER PARAFFIN SCRAPERS



	WELL No. 1		WELL No. 2	
	Year Before Install.	Year After Install.	Year Before Install.	Year After Install.
Paraffin Expense Bbls. Oil Prod.	$1347.00 9859	-0- 9046	$ 767 9978	-0- 8502
Paraffin Cost per Bbl.	$ .137	-0-	$ .077	-0-
Expense Reduction First Yr's Operation	$1347		$ 767	
Installation Cost	401		401	
NET SAVING	$ 946		$ 366	

ROTATING HEAD

This patented head automatically rotates the rod string a fraction of a turn on each reciprocation, so that the scrapers, which clear the tubing by a fraction of an inch, wipe the wall free of paraffin.

Here are the savings a major company made in one year with Huber Scrapers in two of their pumping wells. Well No. 1 saved more than twice the cost of the scrapers. Well No. 2 saved about 90% of their cost. Huber scrapers completely eliminated all paraffin removal expense.

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Representatives in Principal Cities

M. T. Archer dies

Merton T. Archer, director of research for The National Supply Company plant at Torrance, California, and a pioneer in the development of equipment for the petroleum industry, died October 26 at his home in Los Angeles.

Merton T. Archer

A native of Pittsburgh, Archer graduated in mechanical engineering at Carnegie Institute of Technology in 1910. During the war, he was with the Army Ordnance Ferrous Metallurgical Advisory Board as a member of the Sub-committee on Gun Forgings and Cast Armor.

In 1945, he went to Chunking with the Donald Nelson mission as a consultant on metallurgical phases of China's war effort. He recently returned from a four-month's survey of oil field operations in South America.

Reopen Tulsa office

Frank V. Long, president of Vapor Recovery Systems Company, announces that the company's Tulsa office at 533 Mayo Building will be reopened. W. H. "Bill" Worsham, Jr., will be in charge of sales engineering in this area.

Bill Worsham originally hails from Houston, Texas, and holds a B.S.Ch.E. from Rice Institute. During the war he was an engineering officer in the U. S. Army Air Corps. He is a Junior Member of the AIChE, and plans to make his home in Tulsa to better serve the petrochemical industry and sewage disposal operations in that area.

CONSTRUCTION ENGINEERS with experience in construction of petroleum refineries. State education, qualifications, experience, salary requirements, and date available. Address Box 70, % *The Petroleum Engineer*, P. O. Box 1589, Dallas, Texas.

SITUATIONS OPEN: Chemical Engineers with three to five years' experience in the operation of petroleum refining distillation units, thermal cracking units or catalytic cracking units for work as Technical Service representatives and Operators of commercial catalytic cracking plants. Kindly send details of experience and education. Snapshot (if available). Address Box No. 59, % *The Petroleum Engineer*, P. O. Box 1589, Dallas, Texas.

CONSTRUCTION ENGINEERS with experience in construction of petroleum refineries and qualified to take responsible charge of larger refinery construction projects. State education, qualifications, experience, salary requirements, and date available. Address Box 69, % *The Petroleum Engineer*, P. O. Box 1589, Dallas, Texas.

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Hotel Falls Marlin
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Hotel Menger San Antonio
Angeles Courts San Antonio
VIRGINIA
Hotel Mountain Lake Mountain Lake

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HOTELS

Heads association

Thirty-seven-year-old R. B. (Bob) Anderson, manager of the W. T. Waggoner Estate, Vernon, has been elected president of the Texas Mid-Continent Oil & Gas Association. The statewide service and research organization of Texas oil and gas operators elected Anderson to succeed Fred W. Shield, San Antonio oil operator, at the closing session of the group's 28th annual meeting in San Antonio.

R. B. Anderson

Anderson became manager of the Waggoner Estate, which includes extensive oil interests, in 1941. He became general attorney for the estate at Vernon in 1937.

At 22, Anderson began a law practice at Fort Worth, went to the Legislature in 1932, became an assistant attorney general of Texas, and was a professor of law at the University of Texas in 1933. At 24 he was state tax commissioner, was appointed state racing commissioner, and became a member of the state tax board in 1934. He became chairman and executive director of the Texas Unemployment Commission in 1936.

Anderson, who is also a director and deputy chairman of the board of directors, Federal Reserve Bank of Dallas, is a vice president of Associated Refineries, Inc., Duncan, Oklahoma, director of Northwest Broadcasting Company, Inc., Vernon, and president of the Vernon Board of Education. He is also a director of Texas Wesleyan College, Fort Worth.

Fairbanks-Morse changes

Fairbanks, Morse and Company, Chicago, announces the following changes in its sales organization:

J. C. Elmburg, manager of the company's Boston branch house, has been transferred to the company's Atlanta, Georgia, branch house to assume the position of manager of that area. He replaces G. N. Van Epps who resigned recently.

V. O. Harkness, who has been manager of the diesel division at Chicago headquarters, has been appointed manager of the Boston branch and T. M. Robie of Chicago has been appointed to the position of manager of the general diesel sales division.

Solvay appointments

Solvay Sales Corporation, New York, manufacturers of alkalies and related products, has announced the appointment of assistant branch managers in Detroit, Philadelphia, and Syracuse, effective November 1.

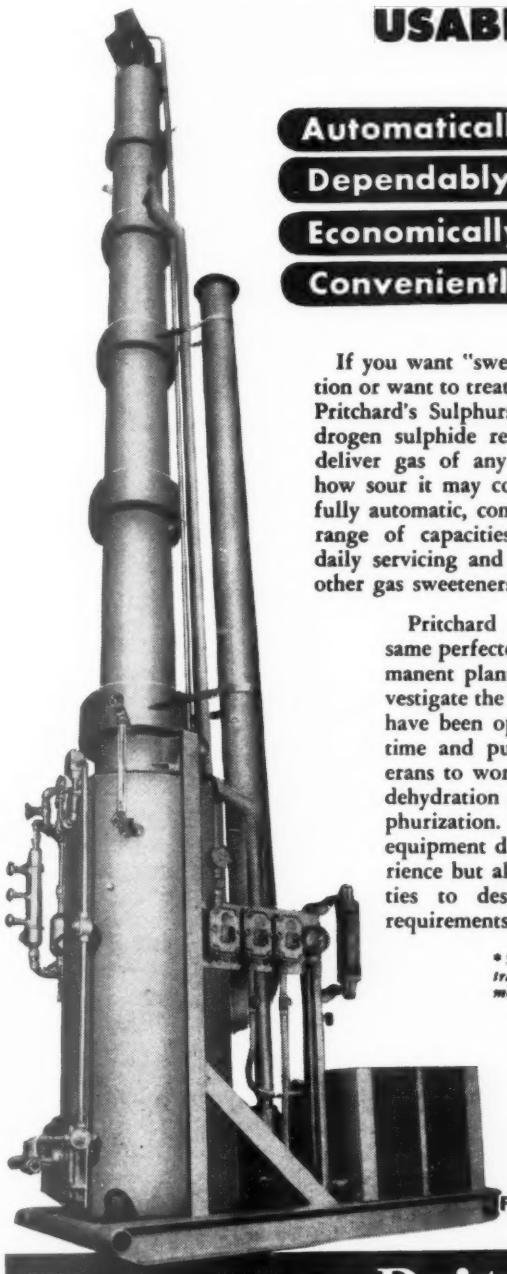
A. B. Kennedy will assume the newly established post at Detroit, K. M. Dillabough at Philadelphia, and J. H. Kaiser at Syracuse. Each of the assistant managers has been a Solvay sales representative in his respective branch for several years.

PRITCHARD'S *New Gas Treater*

the SULPHURSORBER*

Converts SOUR GAS into

USABLE FUEL



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Dependably
Economically
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in any quantities, anywhere

If you want "sweet" gas at an isolated field location or want to treat large volumes at a central plant, Pritchard's Sulphursorber is the answer. These hydrogen sulphide removal units of the amine type deliver gas of any specified purity, regardless of how sour it may come from the well. Available in fully automatic, compact, *portable* design in a wide range of capacities, Sulphursorbers eliminate the daily servicing and hauled-in materials required by other gas sweeteners.

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* SULPHURSORBER *is a registered trade name for gas purification equipment produced by J. F. Pritchard & Co.*

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See Sweets Files, Chemical Engineering Catalog, Refinery Catalog, etc., for additional information on Pritchard engineering and construction services and equipment.

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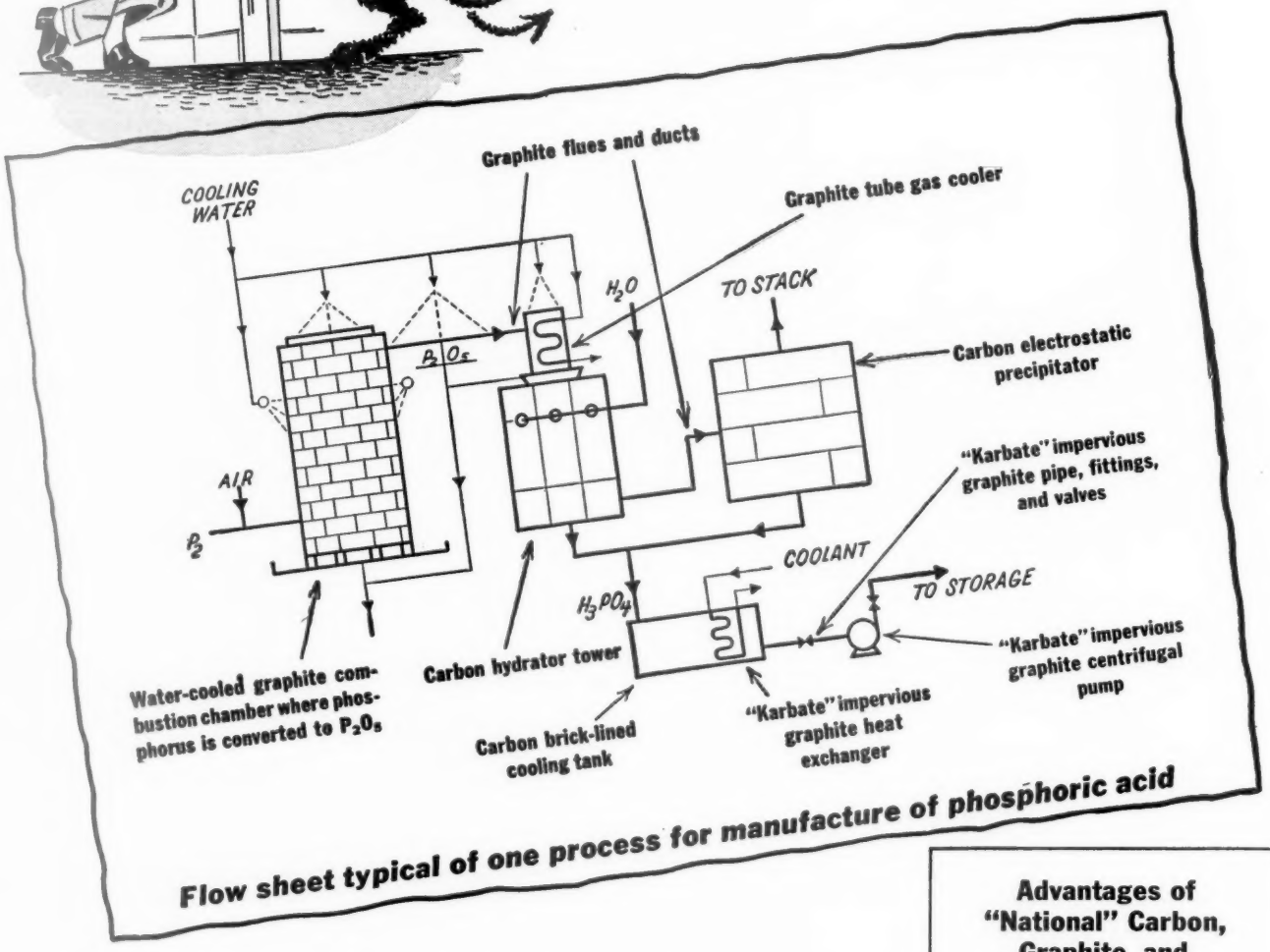
...in manufacturing phosphoric acid...with Carbon, Graphite, and "Karbate" Impervious Graphite



Flow sheet typical of one process for manufacture of phosphoric acid

CARBON, Graphite, and "Karbate" materials are ideal for the construction of complete systems for the manufacture of phosphoric acid and related compounds. They are unattacked by phosphorus, its oxides and acids, or by those contaminants normally encountered in the manufacture of these products.

Graphite material, because of its high thermal conductivity, is required for combustion chambers and gas coolers; but either carbon or graphite is suitable for hydrators and precipitators. Chamber and hydrator construction may be either vertical or horizontal, completely of graphite and carbon, or graphite and carbon-lined steel, depending upon individual design considerations.

Advantages of "National" Carbon, Graphite, and "Karbate" materials

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a daily reference for operating men

INSTALLMENT No. 125

A valuable and regular feature of *The Petroleum Engineer*, the Continuous Tables, now in their eleventh year of publication, were designed to save time and effort for the technician and the practical field or plant worker. The tables have proved one of the most popular and helpful departments of *The Petroleum Engineer*. Data are presented in the simplest form available with many types of information included that are best presented by curves or nomographs when three or more variables must be considered simultaneously.

The Continuous Tables have been developed as a result of suggestions for new tables, direct contributions and improvements to existing tables by members of the petroleum and related industries, including manufacturing concerns, who are continually searching for practical information reduced by computation to tabular form readily applicable to the problems daily confronting them that might otherwise necessitate a more or less tedious calculation. These contributions and suggestions from the industry have resulted in a valuable exchange of information and data contributing to the progress of the industry as a whole.

This index will be revised monthly. The index for installments 1-12, inclusive, will be found in the May, 1938, issue; 13-24, inclusive, in the June, 1939, issue; 25-36, inclusive, in the June, 1940, issue; 37-48, inclusive, in the June, 1941, issue; 48-60, inclusive, in the June, 1942, issue; 61-72, inclusive, in the June, 1943, issue; 73-79, inclusive, in the January, 1944, issue; 80-82, inclusive, in the April, 1944, issue; 83-85, inclusive, in the July, 1944, issue; 86-88, inclusive, in the October, 1944, issue; 89-91, inclusive, in the January, 1945, issue; 92-94, inclusive, in the April, 1945, issue; 95-97, inclusive, in the July, 1945, issue; 98-100, inclusive, in the October, 1945, issue; 101-103, inclusive, in the January, 1946, issue; 104-106, inclusive, in the April, 1946, issue; 107-109, inclusive, in the July, 1946, issue; 110-112, inclusive, in the October, 1946, issue; 113-115, inclusive, in the January, 1947, issue; 116-118, inclusive, in the April, 1947, issue; 119-121, inclusive, in the July, 1947, issue; 122-124, inclusive, in the October, 1947, issue.

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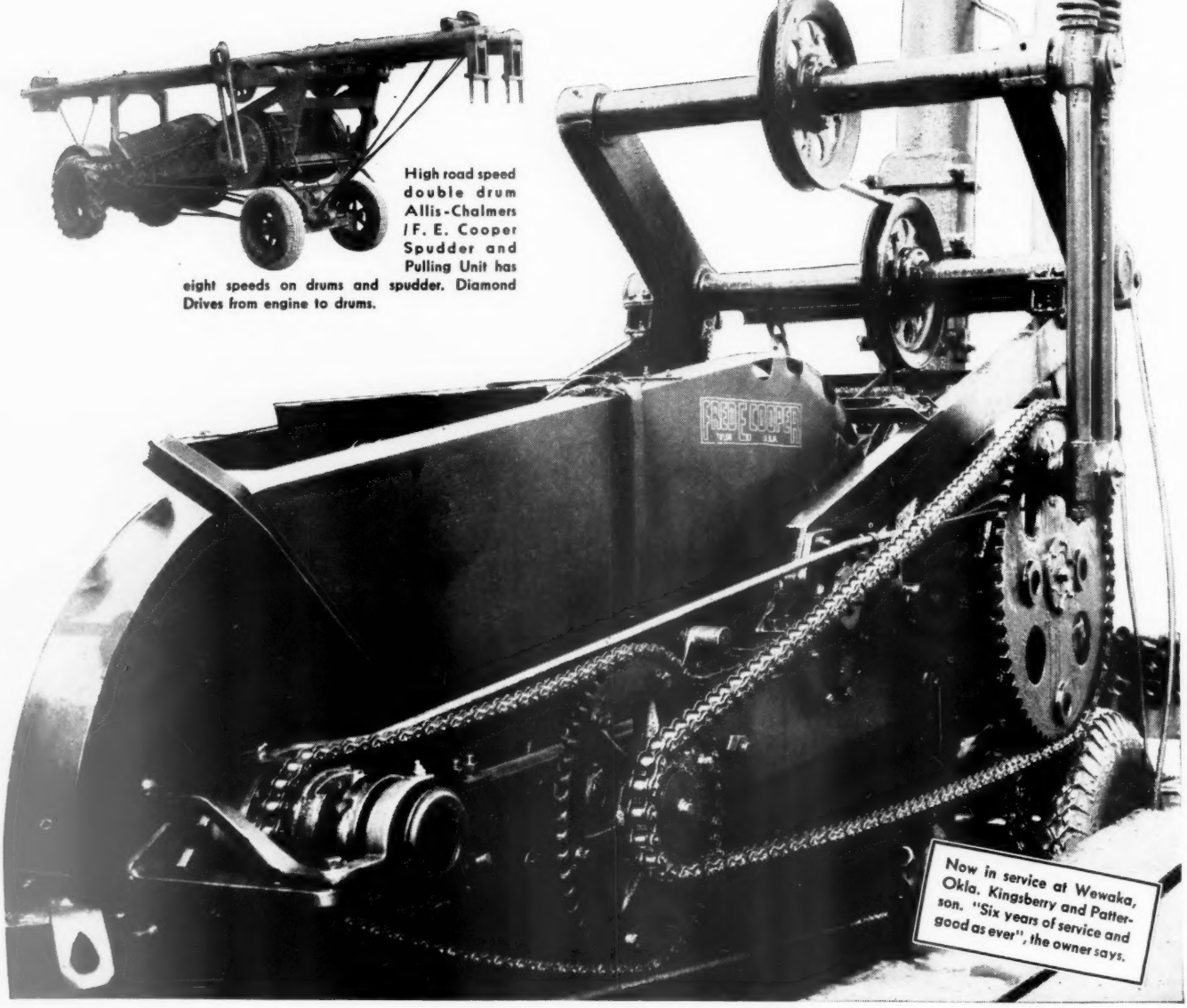


High road speed double drum Allis-Chalmers / F. E. Cooper Spudder and Pulling Unit has eight speeds on drums and spudder. Diamond Drives from engine to drums.

Six Years of Service—and Still Going Strong!

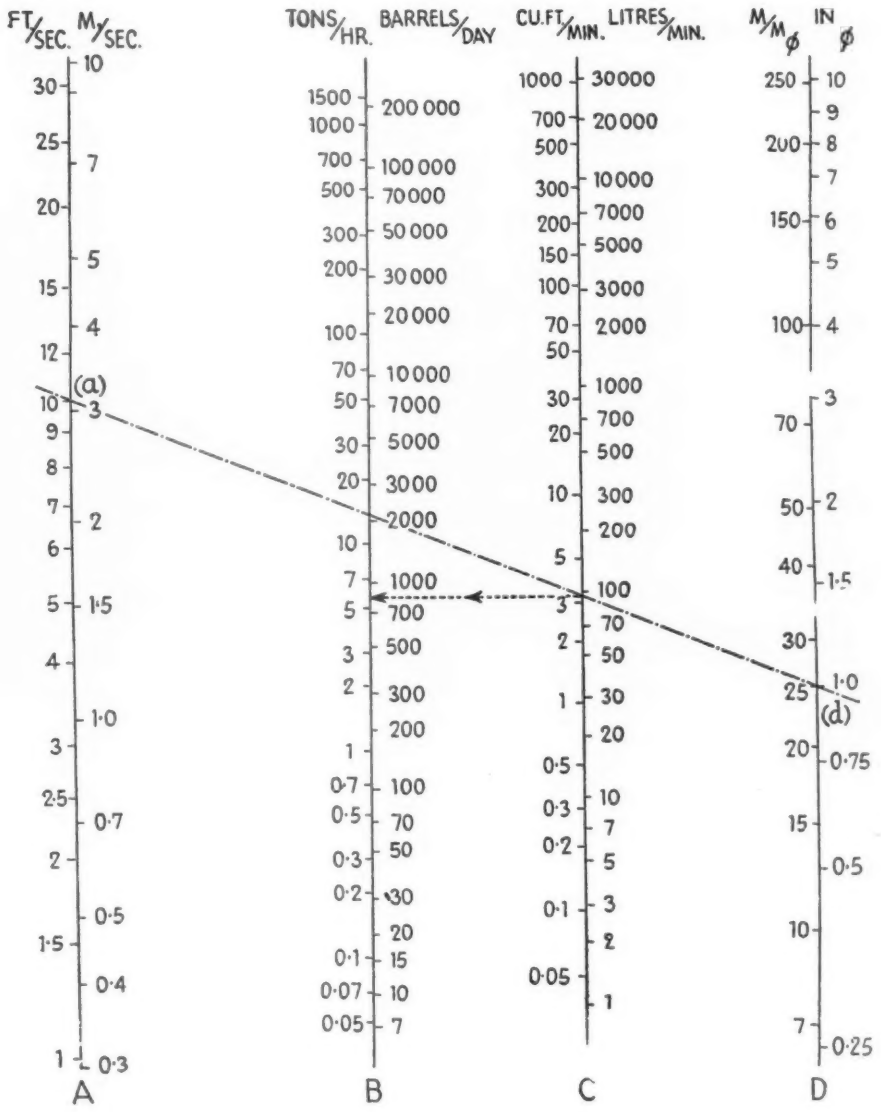
This is by no means a record—but six years of oil country servicing—drilling in and cleaning out wells—is evidence of good design and construction of power drives. This rugged Allis-Chalmers / Fred E. Cooper Servicing Unit is widely used for pulling rods and tubing, bailing, swabbing, rotary drilling, and cable tool spudding to 4500 feet.

Beginning with the first Fred E. Cooper-designed Winch Tractors of nearly 30 years ago and continuing with the present wide range of winch tractors, skid winches, drilling and spudding units, power has been transmitted with Diamond Roller Chain Drives. DIAMOND CHAIN COMPANY, Inc., Dept. 441, 402 Kentucky Avenue, Indianapolis 7, Indiana. *Tulsa Office:* 2238 Terwilleger Blvd.

DIAMOND ROLLER CHAINS

CONVERSION CHART FOR FACTORS IN THE FLOW OF LIQUIDS THROUGH PIPES

NOMOGRAPH



Calculations on the interrelationship between flow of liquids in pipes, pipe diameter, and velocity of the flowing medium are required frequently when designing refineries, pipelines, and other petroleum plants.

The nomograph was prepared to allow a quick solution of these calculations; it is sufficiently accurate for most practical purposes. It can be used also for determining the approximate relationship between "U. S. bbl per day," "cu ft per min," "litres per min," and "tons per hr."

The "tons per hr" line applies only when the flowing medium is water; for other liquids, the figures must be multiplied by their respective specific gravities.

Example:

To find the volume of liquid flowing through a 1-in. diam pipe when the velocity of the liquid is 10 ft per sec:

Place a ruler from the 1-in. diam mark (*d*) on line D to the 10 ft/sec mark (*a*) on line A. The intersection of scale C gives the approximate quantity flowing—namely, 3 cu ft per min or 94 litres per min.

A horizontal line from scale C to scale B gives the approximate quantity in other units—namely, 865 bbl per day, or, in the case of water, 5½ tons per hr. If the liquid is oil of specific gravity 0.9, the tons per hr are $5\frac{1}{2} \times 0.9 = 4.95$.

If the velocity of a liquid in a pipe has to conform to a set figure, the graph can be used to determine the pipe diam required.

NOTE: A "ton per hr" on the above scale is a long ton, or a weight of 2240 lb.

This nomograph was obtained through the courtesy of Philip H. Moore, B.Sc., A.M.I. Chem. E., and F. Inst. Pet. of Moore and Barrett, Petroleum Technologists; Whyteleafe Surrey, England. It was published in *Petroleum*, Feb. 1946, by Leonard Hill Limited, London England.

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METHODS OF EVALUATING AND OPERATING GAS-CONDENSATE RESERVOIRS

Gas-condensate producing fields (also called gas-distillate) are today quite commonplace on the Louisiana and Texas Gulf Coast, but are not confined to that area. The frequency with which they are being discovered and their economic importance in the petroleum industry have increased tremendously with the trend toward deeper drilling. A common understanding of best operating practices by oil operators, land or royalty owners, regulatory bodies, and legislators is necessary if all parties of interest are to cooperate in realizing the maximum potentialities from these fields.

For the purpose of this review, all underground sources of supply from which condensate can be produced are called gas-condensate reservoirs. The name is prefixed with "gas" to emphasize the fact that the condensate is associated with gas when produced. The methods used to evaluate gas-condensate reservoirs, and the basic principles governing the selection of the best method of operation for a particular reservoir, are outlined in the paragraphs that follow.

● **What is condensate?** The terms used in discussing gas condensates have not crystallized as yet into a standard nomenclature. For instance, both distillate and condensate are used synonymously to describe the liquid produced in the tanks. It has been necessary herein to adopt somewhat arbitrarily a set of terms, and to explain the meaning of each term as introduced to avoid confusion.

All are more or less familiar with the fact that some wells produce, together with large volumes of gas, a water-white or light straw-colored liquid that resembles gasoline or kerosine in appearance. This liquid has been called "distillate" because of its resemblance to products obtained in the refinery by distilling the volatile components from crude oil. Also it has been called "condensate" because it is condensed out of the gas produced by the well. The latter term shall be used throughout this paper.

Condensate normally differs markedly from conventional "crude oil." The color of crude oil is usually dark green or black; it feels oily when rubbed between the fingers; it contains some gasoline, but usually is made up in larger part of dark-colored, "heavy" non-volatile components; its API gravity, which is a measure of its weight or density, is commonly less than 45 deg. On the other hand, condensate is light-colored; it evaporates rather easily as compared with crude oil; it contains a large percentage fraction of gasoline and other volatile petroleum components; its API gravity usually is above 50 deg.

Taken from the article, "Gas-condensate reservoirs—a review," by O. F. Thornton, The Texas Company, published in *The Petroleum Engineer*, Reference Annual, 1947, pages 124 to 138, inclusive. This paper was presented before the annual meeting of the American Petroleum Institute, Chicago, Illinois November 12, 1946.

TABLE 1. Comparison of gasoline, condensate, and crude oil.

	White gasoline	Gulf Coast condensate	Crude oil
Gravity, °API	59	54.7	38.6
Color	Water-white	Light-straw	Dark-green
Gasoline, per cent	100	70	31
Kerosine, per cent	..	16	16
Heavier than kerosine, per cent	..	14	53
Cubic feet of gas per bbl of liquid	Distilled from a crude oil	18,200	900

TABLE 2. Compositions of a gas-condensate and a crude-oil-gas mixture.
(All figures in mole per cent)

	Gas-condensate			Crude-oil-gas mixture		
	Gas	Condensate	Reservoir fluid	Gas	Oil	Fluid reservoir
Methane	91.32	..	87.07	92.80	..	57.83
Ethane	4.43	..	4.39	3.79	..	2.75
Propane	2.12	1.41	2.29	1.97	1.61	1.93
Butanes	1.36	5.71	1.74	0.96	2.24	1.60
Pentanes	0.42	8.11	0.83	0.28	2.45	1.15
Hexanes	0.15	10.46	0.60	0.13	3.47	1.59
Heptanes and heavier	0.20	74.31	3.08	0.07	90.23	33.15
Total	100.00	100.00	100.00	100.00	100.00	100.00
API gravity of heptanes and heavier, deg.		51.2			36.9	
Molecular weight of heptanes and heavier		157			226	

Table 1 is a comparison of a typical condensate with a crude oil, which brings out the differences discussed previously herein. Also shown is the amount of gas produced with each, expressed as cubic feet of gas per barrel of liquid. The gas-to-liquid ratios of wells producing gas condensate usually range from 10,000 cu ft to more than 100,000 cu ft per bbl. Gas is produced with crude oil usually in ratios of 100 to over 1000 cu ft per bbl, or much less than with gas condensates.

These limitations of gas-liquid ratios, gravity, and color do not serve to differentiate crude oil and condensate in all cases. Condensates with gravities as low as 40 deg. API have been discovered, and some condensates are produced with gas in low ratios below 10,000 cu ft per bbl.

Now the most important property of condensate from the standpoint of operation of gas-condensate fields is this: The condensate can be "dissolved" entirely in the gas with which it is produced if the temperature is sufficiently high and if there is enough gas present. This is the reverse statement of the familiar phenomenon that a liquid can be condensed out by cooling or chilling many gases.

The temperatures in underground reservoirs containing gas condensate range from 100 to more than 250 F, as measured by thermometers lowered to the bottoms of wells. Similarly, pressures measured with recording gages lowered into the wells are from 1000 psi to over 6000 psi. These conditions are favorable for the gas-condensate mixture to be completely in the gaseous state in the reservoir.

● **Composition of gas condensate.** Knowledge of the gas-liquid ratio and the gravity of the liquid is not sufficient to describe the composition of gas condensate for all purposes. Both the ratio and gravity of condensate depend upon the temperature and pressure at which the separation is made. Therefore, it is customary to express composition in terms of the percentage of each hydrocarbon in the gas, in the condensate, and in the gas-condensate mixture. These percentages are obtained by analyzing the gas and condensate produced, or by analysis of a sample taken at the bottom of a well.

The gas produced from most gas-condensate reservoirs is predominantly methane and ethane with smaller amounts of propane, butane, pentanes, hexanes, and heptanes and heavier, decreasing in that order. The condensate is predominantly heptanes and heavier, with decreasing amounts of hexanes, pentanes, and butanes, and smaller amounts of propane, ethane, and methane. The percentage composition of both the gas and condensate portions of a typical gas condensate are shown in Table 2. Also, the analysis of the gas condensate as it existed in the reservoir is given. These analyses are compared with those of a crude-oil-gas mixture.

The main differences between the gas condensate and the crude-oil-gas mixture noted from Table 2 are: (1) the gas condensate contains relatively large amounts of methane and ethane, which are gases; (2) an appreciable portion of the liquid condensate is composed of propane, butanes, and pentanes, whereas the crude oil is predominantly "heptanes and heavier"; (3) the characteristics of the heptanes and heavier in the condensate and in the crude oil are quite different. That of the crude oil is much heavier, as denoted by its low API gravity and its high molecular weight.

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METHODS OF EVALUATING AND OPERATING GAS-CONDENSATE RESERVOIRS

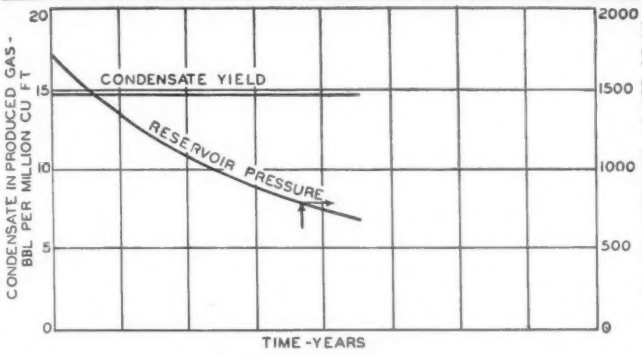

FIG. 1. Performance characteristics of reservoir producing "wet"-type gas.

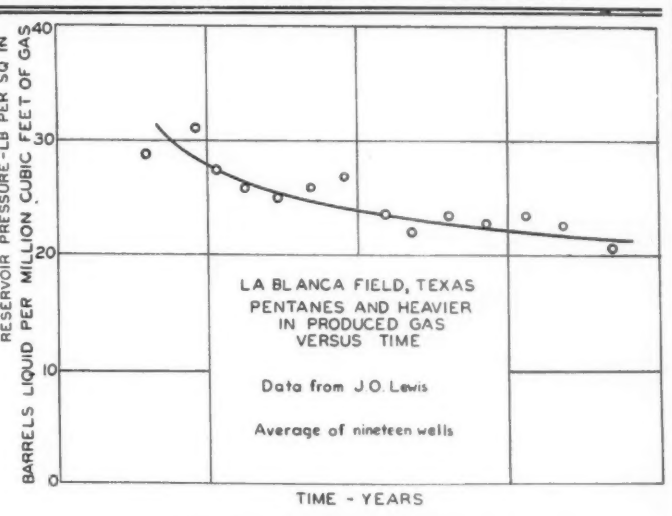

FIG. 2. Decline in condensate yield from a retrograde-type gas.

Propane, butanes, and pentanes are hydrocarbons that can be recovered and sold as liquids if the gas is processed through a plant, but which are not recovered efficiently by conventional separator operation. For this reason, it is usually desirable to consider recovery processes that are more efficient than ordinary low pressure separators when operating gas-condensate reservoirs, in order to extract these hydrocarbons as liquids.

● **Wet gases.** The most familiar gas-condensate reservoirs are of what here will be called the "wet gas" type. This name is adopted merely as a convenience to distinguish them from the other types of reservoirs discussed. Examples of wet gas reservoirs are the Richland field of northern Louisiana and some of the Appalachian gas fields of the East. Very few of the recently discovered gas-condensate fields of the Gulf Coast are of this classification.

Gas produced from a wet-gas reservoir by a well can be passed through a separator operating at a temperature close to that of the atmosphere and a pressure of approximately 500 psi, and a condensate can be recovered. The liquid may be so small in amount that separators are not required; instead the liquid collects in "drips" installed in the flow line, and periodically is blown out. In some cases the quantity of liquefiable hydrocarbons is large enough to justify an extraction plant.

As the gas is produced, pressure in the reservoir drops at a rate dependent on the rate of gas production and the producing capacities of the wells decline. The amount of liquid recoverable from each thousand cubic feet of produced gas, however, remains constant throughout the producing life of a field containing wet gas. The field is abandoned when the pressure in the reservoir has dropped to such a low value (usually less than 500 psi) that the volume of gas and condensate that can be sold from each well is not sufficient to pay operating expenses. In some cases water encroaches into the reservoir and, therefore, the pressure is maintained at a high level. In this event, the field is abandoned when water has flooded out all the wells.

In Fig. 1 are shown typical performance characteristics of a hypothetical wet gas reservoir. The decrease in reservoir pressure, and the constancy of the yield of condensate, will be noted. The distinguishing feature of wet type gas-condensate reservoirs is this: The amount of recoverable liquid that is contained in each thousand cubic feet (often abbreviated MCF) of the gas produced by the wells remains the same at all times. The percentage of the condensate and liquefied hydrocarbons ultimately recovered from the reservoir, therefore, is equivalent to the percentage of the gas recovered, usually 80 to 90 per cent.

It is possible to obtain a sample of the gas-condensate mixture as it exists in the reservoir by lowering a special container down into a well. By a suitable remotely controlled valve arrangement, the sample can be sealed in the container at the bottom of the well, so that the gas condensate does not escape when the "bottom-hole sample" is brought to the surface. Such a sample can then be taken into the laboratory and placed in a bath of the same temperature as that at the bottom of the well. By this means, the condition of the gas-condensate mixture as it existed in the reservoir can be observed. It is found that, in the case of wet gas reservoirs, the gas condensate is completely in the gaseous state at reservoir conditions.

Removal of gas from the reservoir can be duplicated in the laboratory by opening a valve on the sample container and bleeding off the gas[1]. In the laboratory, as in the field, it is observed that the amount of condensate recoverable by cooling the "produced" gas to the temperature of the atmosphere in a separator remains constant at all times. No liquid drops out in the sample container, however, so long as the temperature is maintained at that of the reservoir. In this respect, the wet gas type differs from a second class of gas-condensate reservoirs, which will be discussed hereinafter.

● **Retrograde type gases.** Typical and well advertised examples of the second type of gas-condensate reservoir are the Big Lake field, Reagan County, Texas[2] and the La Blanca field, Hidalgo County, Texas[3]. Here, as in the case of the wet gas class discussed hereinbefore, a liquid condensate was recovered upon passing the gas produced by the wells through separators operating at atmospheric temperature. As the gas was produced, pressure in the reservoir dropped. However, in these cases it was observed that, as the pressure dropped, the yield of condensate from each thousand cubic feet of gas declined. In this latter respect it differed from the wet gas type. Fig. 2 shows how the condensate in gas from 19 wells in the La Blanca field[3] declined from 31 bbl of liquid (pentane and heavier) per million cubic feet of gas (often abbreviated MMCF) down to 22 bbl per million in three years—a reduction of 29 per cent. Obviously, a considerable portion of the condensate remained in the reservoir and was not produced. The loss of this condensate was of sufficient magnitude to be of economic importance.

Taken from the article, "Gas-condensate reservoirs—a review," by O. F. Thornton, The Texas Company, published in *The Petroleum Engineer*, Reference Annual, 1947, pages 124 to 138, inclusive. This paper was presented before the annual meeting of the American Petroleum Institute, Chicago, Illinois November 12, 1946.

NOTE: References will be found on the last sheet in this series of tables.

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THERMAL METHOD OF LOCATING TUBING LEAKS IN GAS-LIFT WELLS

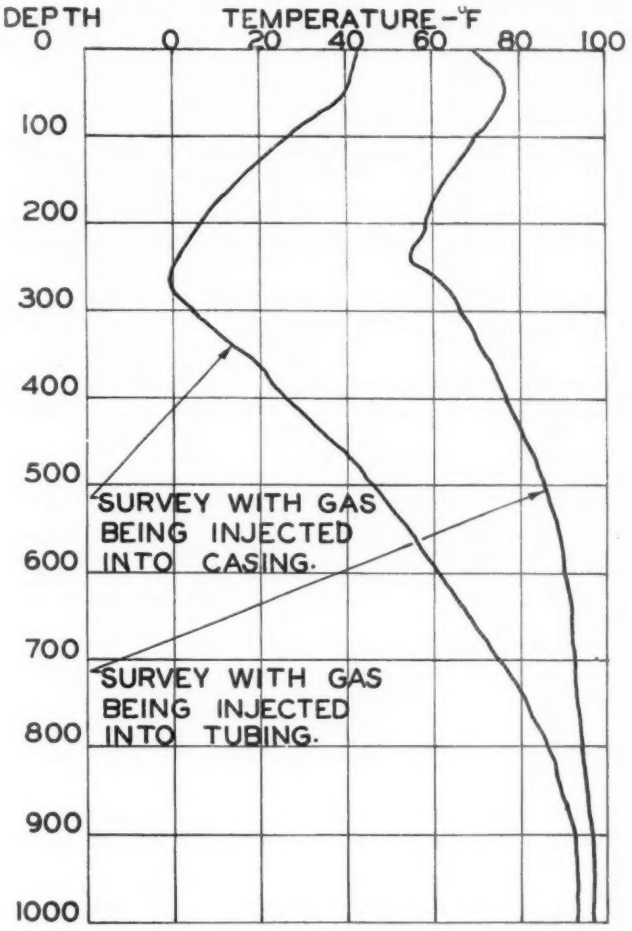
Thermometric measurements often provide a means of obtaining information about conditions taking place outside of one or more strings of pipe. This is illustrated in Fig. 1, where a collar leak in the tubing caused an ice bridge to form more than 200 ft below the surface between the tubing and the casing.

The well had been put on gas lift, and the gas was injected in the casing to lift the fluid through the tubing. The normal injection pressure of 500 psi gradually built up to 1100 psi and the well stopped producing oil although some gas continued to flow up the tubing. A thermometric survey run in the tubing indicated a temperature of 1 deg below 0 F at a depth of 275 ft. A check was made of the pressure between casing strings and it was found to be normal at 250 psi, eliminating the possibility of a casing failure. The injection of gas was reversed from the casing to the tubing and after about 24 hr the well began to produce a small amount of fluid. Two days after the first thermometric survey, a second survey was made with the gas being injected in the tubing, and the lowest temperature recorded was 56 F at 240 ft, indicating that the annulus between the tubing and the casing had been frozen up through a considerable area. In order to thaw out all the area affected, the well was kept on production with the gas being injected in the tubing and the well producing through the casing. After several days the injection pressure dropped gradually as the thawing was completed.

Three hundred feet of tubing was pulled and a bad collar leak was found at 218 ft. The flow of gas through the collar leak apparently started the freezing action and the ice accumulated in the annulus for a considerable distance. The condition in this well was probably very unusual, but there are many conditions affecting the production of flowing wells that are unusual. Many of these conditions might be considered usual if more were known about what was happening in all wells. The instrument on this survey was run at the rate of 6000 ft per hr, and the results show clearly the quick response to the temperature changes and the necessity for continuous recording.

Migration of water behind casing is common in some areas, and thermometric surveys sometimes have indicated water moving from one zone to another 2000 ft higher. Although a condition of this kind may not cause a casing failure for several years, the information about what is taking place can be used to help prevent the same condition occurring in new wells drilled in the same area.

FIG. 1. A temperature survey when gas was being injected into casing shows that an ice bridge formed below 200 ft.



In some fields where multiple completions of several zones were made by the use of various mechanical devices, some of the zones have been produced at a higher rate than others. Due to failure of the mechanical separation of the zones, oil and gas is migrating into the more depleted sands. Large quantities of this migrated oil may never be recovered. Thermometric surveys can be used to detect such migration of oil and gas. Although the instrument is run through the tubing, migration may be detected through several strings of pipe.

Pressure studies frequently are made to obtain information necessary to maintain reservoir pressures, and yet migrating gas and oil can escape from the reservoir to low pressure sands, due to mechanical failures, without being detected by normal operating procedure. One producing well in a field being repressured did not indicate any migration of oil or gas and the condition was not detected on a flowing temperature survey. A shut-in temperature survey was made and it indicated gas was migrating from the producing zone around the casing shoe and into a low pressure sand above. A study of the history of the well disclosed that when the casing was run it froze, and the subsequent cementing job was of doubtful effectiveness. The well had then been cemented through perforations at a higher level. The thermometric surveys made on this well did not indicate how much gas was migrating, but they did disclose that gas was moving into low pressure sands that were supposed to be excluded from the well. The gas, therefore, was not contributing to the building up of the reservoir pressure.

Taken from the article, "Temperature surveys in producing wells," by Clarence R. Dale, published in *The Petroleum Engineer*, September, 1947, pages 146 to 148, inclusive.

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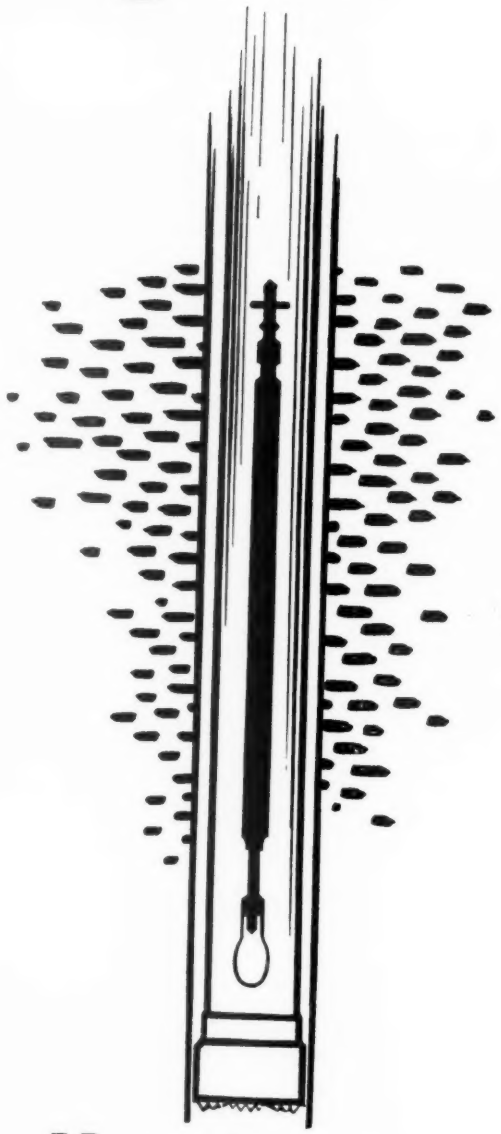

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THERMAL METHOD OF LOCATING CASING LEAKS IN PRODUCING WELLS

Migrating gas caused serious trouble recently when a drilling well blew out at 1400 ft. It was cemented and the cement was drilled out with heavy mud. Again, all mud was blown out of the hole. Two producing wells near to this drilling well would flow outside of the casing when opened up. Thermometric surveys on these wells, made with mud, water, and gas flowing outside the casing, while the tubing was shut in, indicated the fluid and gas were coming from shallow depths that were known to have a lower pressure than the gas that caused the blowout of the drilling well. Surveys were then made on a number of flowing wells in the area around the blowout well to detect upward migration. The surveys were made with the wells shut in. Pressure traverses were also made on some of the wells as the work progressed. One well several hundred feet from the drilling well was found to have an abnormally high fluid level when shut in. It was suspected that this well might be causing the trouble. On a shut-in temperature survey there was no indication of migrating gas. In order to find out whether there was a hole in the casing, gas was injected in the casing, and the pressure leveled off at approximately 1500 psi. A static thermometric survey was run in the tubing. A hole was detected in the casing (Fig. 1). When this well was flowing, gas would migrate out through the hole in the casing and travel through a fault over to the drilling well with sufficient pressure to blow the mud from the hole. The well was shut in and the migration stopped due to fluid entering the well and balancing the formation pressure.

In Fig. 2, the static geothermal gradient was determined by a survey made after the well had been shut in for several days. The flowing temperature survey was made at a steady rate of flow. The temperature below 6400 ft on the flowing survey follows the static geothermal gradient, because the fluid was static from 6400 ft to the bottom of the well. Above 6400 ft the geothermal and flowing curves separate, the upward movement of fluid producing an almost vertical gradient on the flowing survey. These surveys established 6400 ft as the lowest point from which the well was producing.

Although the bottom of the tubing was above the liner in this well, the same results would have been obtained with the bottom of the tubing anywhere in the liner, if the well had been produced through the casing during the survey. Thermometric surveys are made usually after some change has taken place in the well, such as gas entry, migration of fluids, water entry, and other conditions affecting the production.

FIG. 1. A hole in the casing was detected near 2700 ft by a static temperature survey after the well fluid was depressed by injected gas.

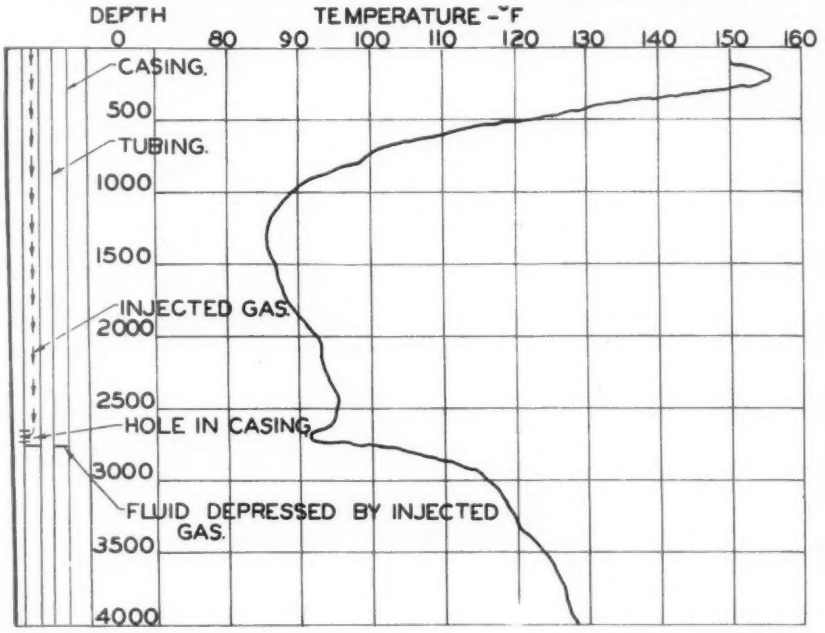
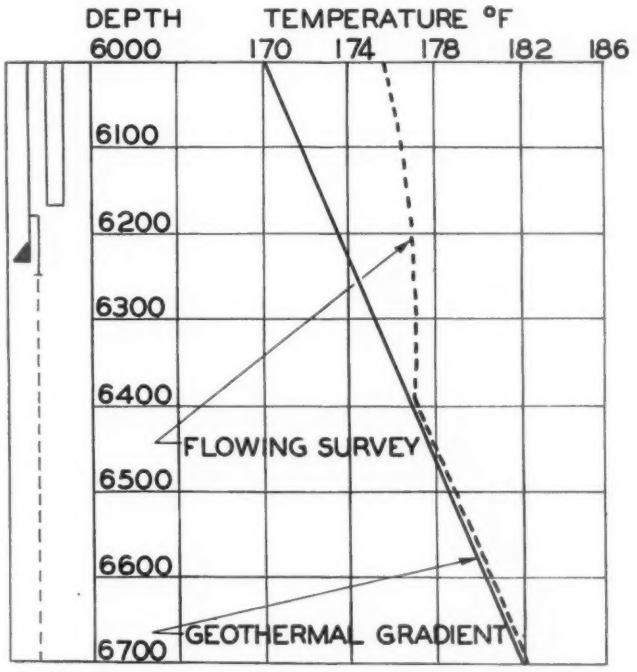


FIG. 2. A static temperature survey (geothermal gradient) of a 6700-ft well shows a regular increase in temperature with depth from 170 F at 6000 ft to 182 F at 6700 ft. The flowing temperature survey shows very little increase from 6000 ft to 6400 ft. This indicates that no production is obtained below 6400 ft when the well is flowing.



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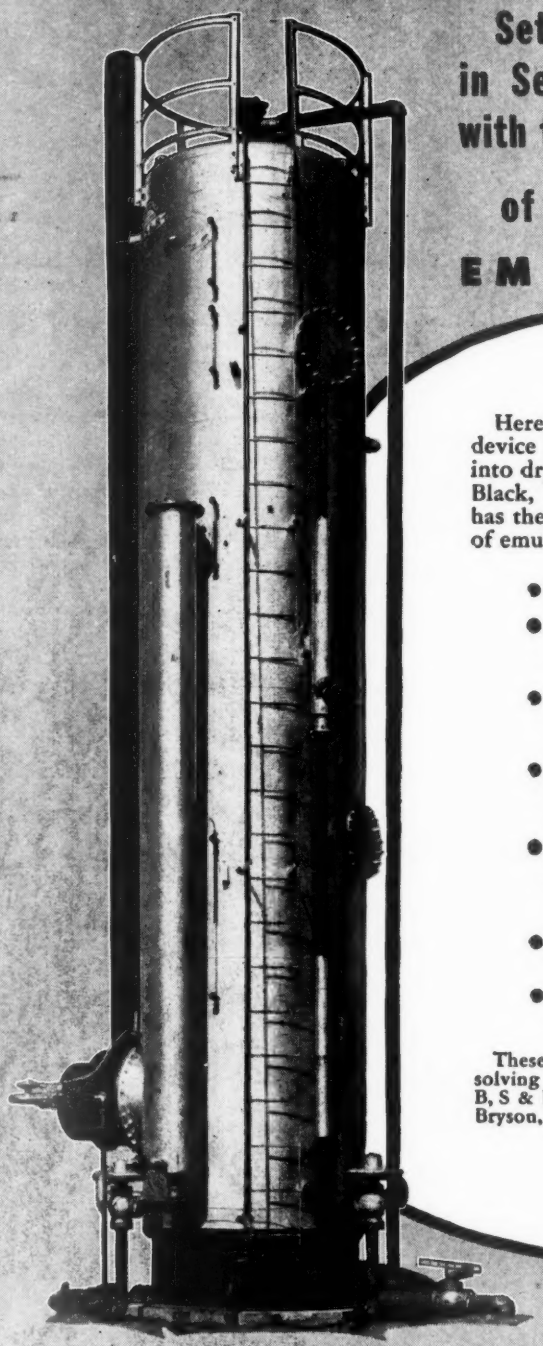

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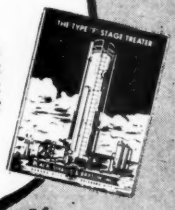

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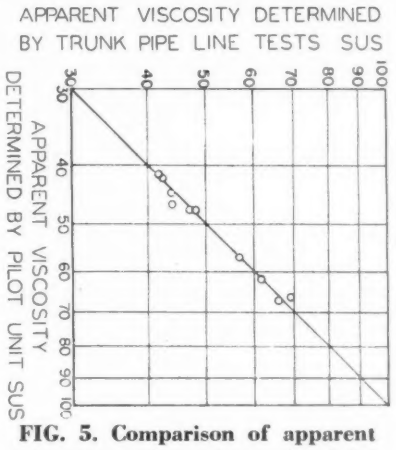


FIG. 5. Comparison of apparent viscosity values determined by pilot unit and trunk pipe line tests.

The viscosity data obtained throughout these studies are plotted on *ASTM Standard Viscosity-Temperature Charts for Liquid Petroleum Products* (D-341-39) for convenience, since a straight line relationship generally exists for petroleum oils when the data are plotted on this chart.

To establish the validity of the pilot unit data in the waxy region it was necessary to compare the flow characteristics of a waxy oil in the pilot pipe-line unit with corresponding values observed on a commercial scale trunk pipe line. To do this, a series of tests was run on a 40-mi. section of Humble Pipe Line Company's 10-in. trunk pipe-line system, during which complete flow data were observed and composite samples of the crude flowing in the trunk line at the time were taken. A scraper was run through the trunk line immediately before each test was conducted to preclude the presence of wax on the walls of the pipe. From the flow data, the apparent viscosity of the crude flowing, at the operating temperature, was calculated. This value was compared then to an apparent viscosity value calculated from the pilot unit data obtained at the same temperature on the sample of crude collected during trunk pipe-line test run.

The ten test runs that were carried out on the trunk pipe line covered a viscosity range of 42 to 67 Saybolt Universal Seconds (SUS) at operating temperatures from 49 to 90 F. The apparent viscosity values obtained with the pilot unit on composite samples of the crude from each of the test runs agreed closely with the corresponding apparent viscosity calculated from the pipe line test data. A comparison of the pilot unit and trunk pipe-line viscosity values is presented in Fig. 5.

TABLE 3. Apparent viscosity determinations—pilot pipe-line unit experimental data.

Feed stock composition: Crude, December test sample, H.P.L. Co.
Laboratory inspections: Gravity at 60 F=39.8° API.
Laboratory viscosity, SUS=43″ at 90 F; 40.7″ at 100 F; 37.0″ at 130 F.

Run number	Net pressure drop, psi	Flow rate, gpm	Average temperature, F.	Friction factor, f	Reynolds number, N_{Re}	Apparent viscosity, SUS
1	78.4	1.240	32.0			206
2	103.9	2.340	36.0			146
3	87.0	2.400	40.0			121
4	93.8	2.820	40.0			112
5	82.8	3.440	46.0			85
6	67.0	2.550	46.5			90
8	56.5	2.870	55.0			73
9	57.9	2.520	64.0	0.0410	3000	54
11	17.6	1.438	64.0			54.5
15	100.5	3.605	78.0	0.0353	5700	46.7
16	65.8	2.875	84.0	0.0364	5000	44.8
17	75.0	3.110	85.0	0.0354	5600	44.2
18	56.6	2.665	92.0	0.0364	5000	43.5
19	45.3	2.390	93.0	0.0364	5000	41.7
20	57.8	2.765	100.5	0.0347	6300	40.4
21	49.8	2.550	100.5	0.0352	5800	40.4
23	49.9	2.605	111.0	0.0339	7000	38.3
24	67.6	3.110	48.0			79.0
25	59.7	2.890	49.0			76.0
27	21.7	1.335	56.5			64.0
28	60.0	2.605	67.0	0.0398	3400	51.0
29	68.9	2.820	67.5	0.0392	3700	51.0
30	67.6	2.905	82.0	0.0364	5100	44.6
31	59.9	2.700	82.0	0.0374	4500	45.5

Runs 10, 13, 14, 22, and 26 were in critical region of Reynolds Number.

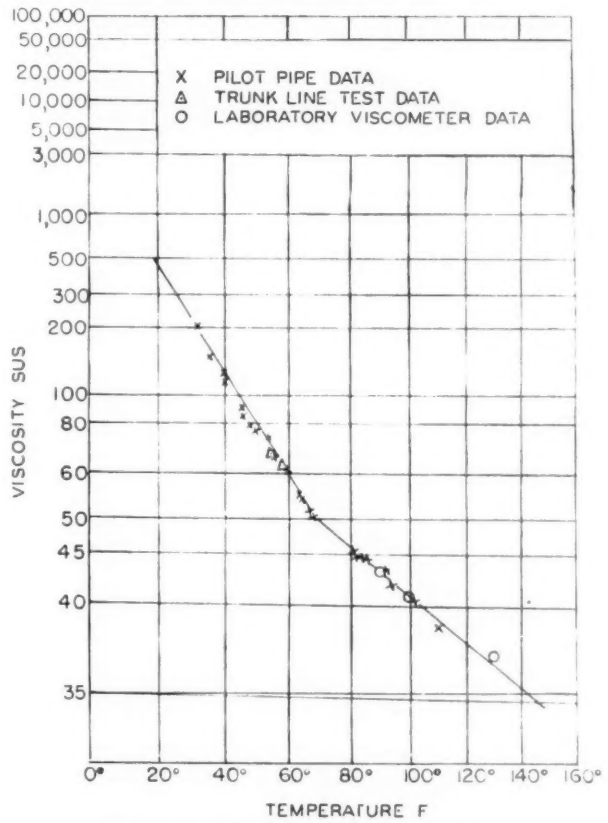
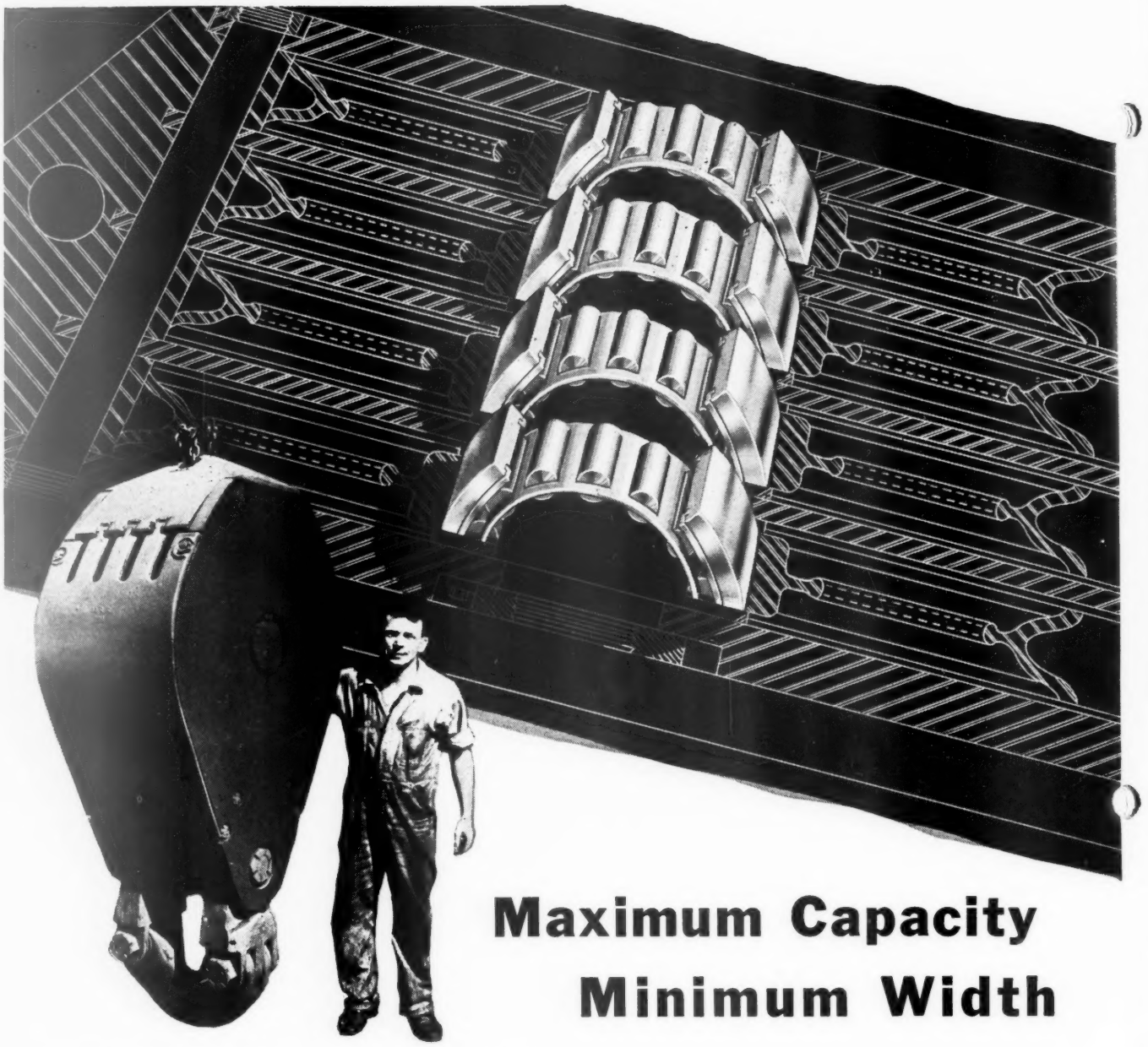


FIG. 6. Apparent viscosity of crude, December test sample 39.8 API.

Taken from the paper, "Pilot pipe line unit for determining viscosity—temperature relationships," by R. B. Beckman, H. G. Corneil, and R. J. Michael, Humble Oil and Refining Company, in *The Petroleum Engineer*, Reference Annual, 1947, pages 263 to 268, inclusive.



Maximum Capacity Minimum Width

Streamlined shape and rugged construction speak for the stamina of this new McKissick Traveling Block. But a look inside, where four Hyatt Roller Bearings carry a 200-ton load, shows how the bearings contribute to highly efficient design and operation.

These bearings are Hyatt Hy-Load Type, which feature high radial capacity for minimum bearing width—making possible the narrow sheaves for block compactness which, in turn, permits maximum derrick working space.

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HYATT ROLLER BEARINGS

APPARENT VISCOSITY OF WAXY CRUDE OILS AT PIPE LINE CONDITIONS

As good agreement was obtained between the pilot unit and trunk pipe line apparent viscosity values throughout the waxy as well as the non-waxy temperature ranges, it was concluded that pilot unit values were reliable. A further indication that the pilot unit values were reliable is that the apparent viscosity values obtained were identical at any given temperature over a broad range of flow rates regardless of whether the oil was waxy or non-waxy or the flow viscous or turbulent. This is contrary to the usual behavior of heterogeneous fluids.

● **Typical examples of data obtained on the pilot pipe-line unit.** To illustrate the accuracy and range of the data obtained on the pilot unit several examples of the data are presented.

In Fig. 6 and Table 3 are presented the data obtained on the pilot unit on the crude sample collected during the December, 1944, test run on the trunk pipe-line system. Fig. 6 illustrates both the agreement between pilot unit and laboratory values in the homogeneous region and the agreement between the apparent viscosity calculated from the pilot unit data and that calculated from the trunk pipe-line tests.

In order to investigate both the operable range of the pilot unit and the effect of increasing waxiness on the apparent viscosity in the waxy region, samples of residuums obtained from a waxy crude were blended in varying proportions with the original crude and the blends were evaluated for viscosity-temperature characteristics on the pilot pipe-line unit. In Fig. 7 are presented typical data obtained from several of these blends. The right-hand plot shows the apparent viscosity-temperature relationship for the actual blends and in the left-hand plot the data are cross-plotted to permit easy interpolation to any percentage blend at varying temperatures. The same ASTM chart used for expressing the viscosity-temperature relationships can be used for cross-plotting to viscosity-percentage relationships by using the portion of the ASTM chart between 0 F and 100 F and converting the temperature ordinates to percentage ordinates.

The above examples have been cited to illustrate but two of the uses for which this type of pilot unit may be employed. As previously mentioned, the technique and apparatus involved should prove useful for obtaining apparent viscosity values for use in hydraulic calculations for many high vapor pressure and/or heterogeneous systems wherein the conventional laboratory viscometers are not satisfactory.

● **Suspension of wax.** Wax crystals suspended in the oil are prevented from settling in the blend tank of the pilot unit by maintaining the flow rate of the oil that bypasses the test section of a maximum, thus insuring complete agitation of the oil reservoir. In commercial practice the trunk pipe lines are cleaned periodically with a mechanical scraper. The trunk line tests were run immediately following such a cleaning to insure each of the test's being run under known, identical conditions of inner pipe surface.

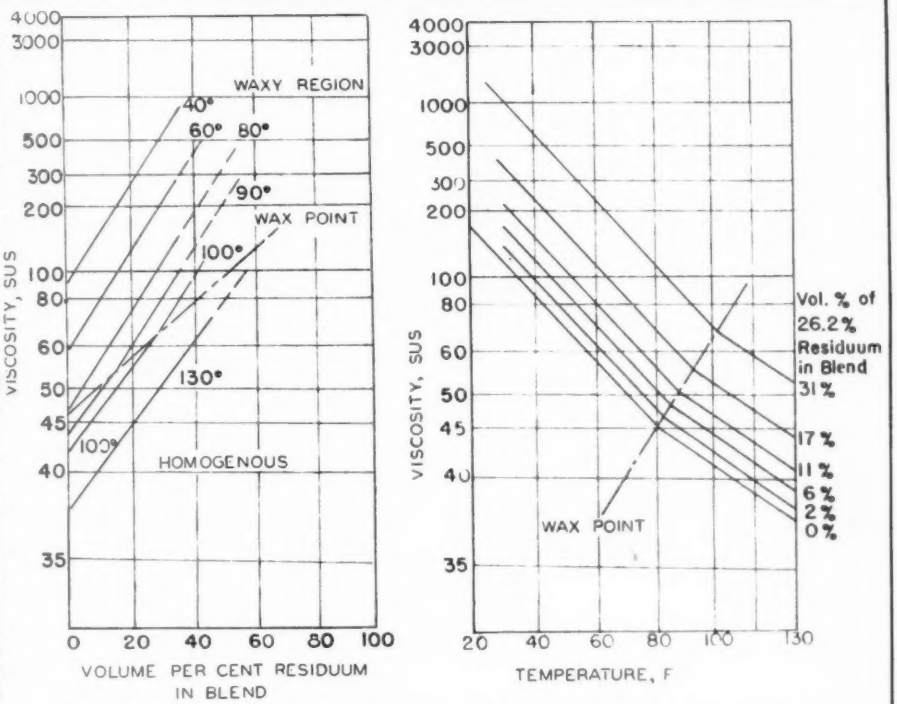

FIG. 7. Apparent viscosity of crude and 26.2 per cent residuum blends.

● **Apparent viscosity.** It was found during this study that the apparent viscosity calculated from the flow data was not dependent upon the rate of fluid flow through the test section at any given temperature level. If the waxy oils had exhibited the usual heterogeneous fluid characteristics, i.e., variation of viscosity with shearing rate, a different apparent viscosity would have been obtained with each flow rate employed at any given temperature. It must be borne in mind that no attempt has been made in this study to calculate a true viscosity, but rather an apparent viscosity value that can be used with some assurance in hydraulic calculations. It is not known whether the pilot unit could be used on fluids of known heterogeneous behavior and the pilot unit would have to be calibrated for such a material to determine whether the apparent viscosity values were accurate.

● **Appendix.**

The following is a resumé of the fluid flow equations used throughout this study:

1. Fanning equation for both viscous and turbulent flow:

$$P = \frac{flpv^2}{2g_oD} \quad \ldots\ldots (1)$$

Where:

P = pressure drop, psf,
f = friction factor,
l = length of test section, ft,
p = density of fluid flowing, lb per cu ft,
v = velocity of fluid flowing, fps,
g_o = acceleration of gravity = fps^2,
D = diameter of pipe = ft.

2. Poiseulles law for viscous flow:

$$f = 64/N_{Re} \qquad P = \frac{64lpv^2}{2g_oDN_{Re}}$$

Where:

N_{Re} = Reynolds Number, using values in the units expressed in the above table and viscosity in (lb per sec) (ft).

3. Turbulent flow: From equation (1), Fanning equation, the friction factor was calculated from the test data.

The Reynolds Number (N_{Re}) was obtained from the calibration plot of f — vs — ϕ (N_{Re}), and the absolute viscosity in centistokes was calculated from the Reynolds Number. The viscosity values in centistokes were converted to Saybolt Universal Seconds by use of *ASTM Conversion Tables for Kinematic and Saybolt Universal Viscosities.*

Taken from the paper, "Pilot pipe line unit for determining viscosity—temperature relationships," by R. B. Beckman, H. G. Corneil, and R. J. Michael, Humble Oil and Refining Company, in *The Petroleum Engineer*, Reference Annual, 1947, pages 263 to 268, inclusive.

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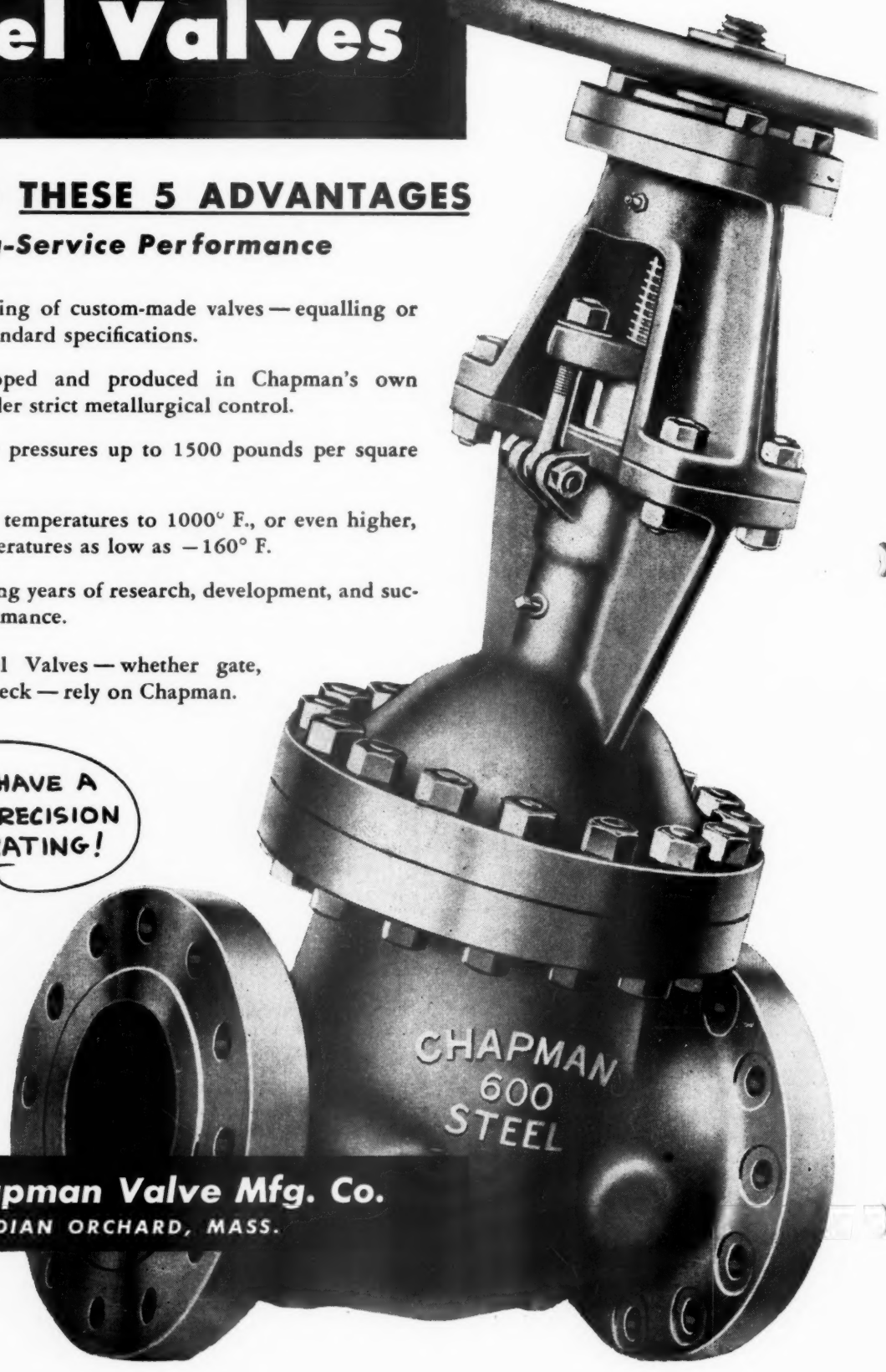

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District managers

Due to the need for expanded service facilities, Baker Oil Tools, Inc., announces the appointment of additional district managers as follows: C. J. Berlin, Dallas district with headquarters at Dallas; E. F. Hannon, Texas Gulf district with headquarters at Houston; H. F. Harper, Southwest Texas district, with headquarters in Corpus Christi; A. K. Kline, Olney district with headquarters in Olney, Illinois; G. E. Turner, Louisiana Gulf district with headquarters in Harvey, Louisiana.

C. J. Berlin

E. F. Hannon

H. F. Harper

A. K. Kline

G. E. Turner

R. C. Glover

R. D. McBrian

R. C. Glover will continue as district manager of the Tulsa district, and R. D. McBrian will continue as district manager of the West Texas district with headquarters in Odessa.

NACE conference

The fourth annual Conference and Exhibition of the National Association of Corrosion Engineers will be held April 5-8, 1948, at the Jefferson Hotel, St. Louis, Missouri.

Moves offices

Republic Supply Company announces the removal of its general offices and district sales office from the Petroleum Building to the recently enlarged National Standard Building at the corners of Main and McKinney streets, Houston, Texas. Republic has maintained its general headquarters in the Petroleum Building for the last 19 years.

In its new quarters, Republic's rapidly expanding organization will be on the 12th, 13th, and 14th floors. General sales and executive offices will occupy the 12th and 13th floors with district sales offices on 14th.

During the past several years Republic has added a number of new supply stores and sales offices throughout the middle-western area and today serves the oil industry from 50 sales and service points ranging from Chicago to South Texas and Mississippi to Colorado.

Phillips fellowship

The College of Engineering of the University of Oklahoma announces establishment of a graduate fellowship in petroleum engineering by the Phillips Petroleum Company. Established for an initial period of one year, the fellowship carries a stipend of $1200.

The holder of this fellowship will do research on oil production under the direction of Dr. John C. Calhoun, Jr., associate professor of petroleum engineering.

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Happy Company holds annual sales conference

District men at Tulsa headquarters of Happy Company.

The accompanying photograph was taken at the annual sales conference of the Happy Company recently held at the company offices in Tulsa, Oklahoma. District men attended from Salem, Illinois; Wichita and Ellinwood, Kansas; Seminole, Oklahoma, and Kilgore, Odessa, Wichita Falls, and Pampa, Texas.

The Happy Company is closing its 27th year in Tulsa. Its principal products are Happy pumping units, Young-Happy cooling equipment, and a complete line of Boston woven hose and belting.

Officers of the company are Paul E. Mahaffey, president, Leo C. King, vice president and sales manager, and Roy C. Lindley, secretary-treasurer.

AAODC convention

A new record in attendance was set at the Seventh Annual Meeting of the American Association of Oilwell Drilling Contractors in Long Beach, California, October 13-15, with a total registration of 777. Although this was the official count, the barbecue and banquet drew an extra large number of guests from the oil fraternity in the Long Beach vicinity. Attendance at the barbecue was at least double the number of convention registrations.

Most convention activities took place in the large Municipal Auditorium, which was ideally suited to requirements. Committee meetings Monday morning were first on the program, these being the rotary drilling, research and educational, safety and insurance, publications, accounting and nominating committees.

An address of welcome by Mayor Burton W. Chace of Long Beach was followed by a report of the year's activities by J. E. Warren of Midland, Texas, the outgoing president. Irving Smith, Long Beach city attorney, and Frank Hardesty and John Rumbaugh, petroleum production engineers of the Long Beach Harbor Department, explained various phases of the important oil development surrounding the Long Beach Harbor. This was followed by an impressive tour of the outer and inner harbors under direction of W. R. (Frosty) Martin, chairman of the Long Beach Harbor Commission.

After various committee reports on Tuesday morning, speakers at the after-

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noon session were Martin E. True, Humble Oil and Refining Company, Houston, who discussed "Automatic Drilling Control," and K. A. Wright and Bruce Barkis, B. & W., Inc., Long Beach, who spoke on "Effect of Hole Enlargement on Cementing and Completion Practices." This session ended with the report of the nominating committee meeting of directors.

On Tuesday evening the stag barbecue at the Lakewood Country Club attracted a record attendance. Wives of all visitors were entertained at a gala brunch and fashion show in the Pacific Coast Club Tuesday with approximately 200 in attendance, including guests from several Pan-American countries.

"The Drilling Situation Today" was discussed by J. D. Spalding, National Supply Company, Torrance, California, at the Wednesday morning session. John M. Forline, labor relations consultant, Los Angeles, delivered an interesting address on the "Manners of Management."

New officers were installed Wednesday noon at the final luncheon at the Wilton Hotel. At the afternoon session Wiley B. Noble, Reed Roller Bit Company, Houston, spoke on "Fundamental Considerations in the Design of Rock Bits." The closing address was made by Reese H. Taylor, president, Union Oil Company of California, whose subject was "Telling the Fact."

Past presidents of the association presided at the general sessions during the convention. A large banquet in the Convention Hall of the Municipal Auditorium Wednesday evening was an outstanding feature of the program. E. L. Decker presided as toastmaster and displayed unusual talent. Guests of honor included two California officials, Goodwin J. Knight, lieutenant governor, and Fred N. Howser, attorney general, and Captain Anton Mare, port director of Terminal Island. "Red" Skelton and Jo Stafford were featured entertainers of the evening, the program including a varied and entertaining stage show following the banquet itself.

The various California committees worked hard to make the meeting outstanding in every respect, and Long Beach set an entertainment standard that will be hard to equal in the future.

Association officers and directors for the new year are as follows:

Officers: E. C. Brown, Long Beach, California, president; Joe S. Morris, San Antonio, Texas, vice president at large; George F. McQueen, Fort Worth, Texas, vice president for West Texas and New Mexico; D. B. Ferguson, Carmi, Illinois, vice president for cable tools; Lester D. Cain, Houston, Texas, vice president for Gulf Coast; William Broadhurst, Tulsa, Oklahoma, vice president for Central Mid-Continent; D. H. Graham, Long Beach, vice president for California; R. M. Olds, Mt. Carmel, Illinois, vice president for Illinois, Michigan, Indiana and Kentucky; J. Zeppa, Tyler, Texas, vice president for Cretaceous and Tertiary Basins; E. E. Pickering, Houston, vice president for well servicing; C. J. Paine, Dallas, Texas, treasurer; Brad Mills,

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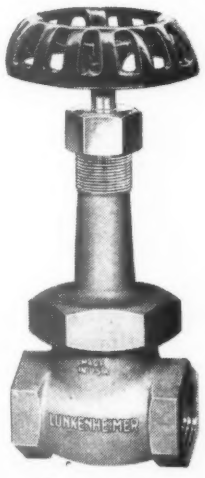

Fig. 2228
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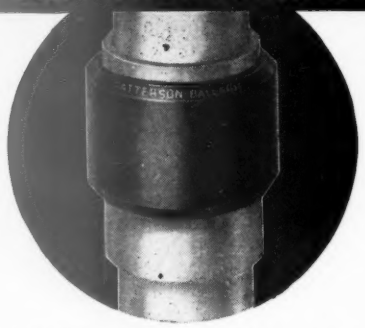

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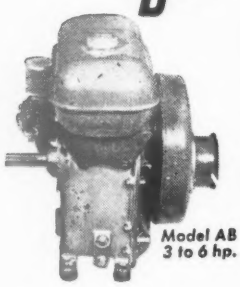

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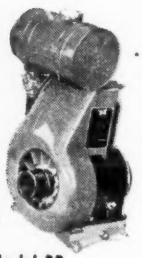

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Regional directors: Pacific Coast Region: A. S. Hayes, Los Angeles, California; Karl L. Kellogg, Long Beach; Gene Reid, Bakersfield, California; Ralph W. Marshall, Los Angeles, and Thomas P. Pike, Los Angeles.

North Central Texas: J. Alvin Gardner, Dallas; Harold R. Delaney, Dallas, and John J. Moran, Wichita Falls.

Cretaceous and Tertiary Basins: James R. Nowery, Shreveport; Dorris Balley, Natchez, Mississippi, and J. I. Roberts, Shreveport.

North Central Paleozoic Basin: J. V. Dunbar, Salem, Illinois; E. D. Harmon, Tulsa, and Guy B. White, Evansville, Indiana.

Permian Basin: Guy Mabee, Midland; C. M. Ashby, Dallas, and Leif Olson, Tulsa.

Central Mid-Continent Basin: Travis M. Kerr, Oklahoma City; S. R. Mealy, Tulsa, and Mark Gardner, Tulsa.

Gulf Coast Region: H. C. Fitzpatrick, Corpus Christi; Al Buchanan, San Antonio, and Roger J. Wolfe, Houston.

Appalachian Region: Wallace W. Haupt, Greensburg, Pennsylvania, and Arland Fox, Washington, Pennsylvania.

Training film

"Quick Change" is the title of a new training film recently completed for Cameron Iron Works, Houston, Texas. Show Time: 20 minutes.

Filmed in technicolor and with narration, "Quick Change" illustrates the speed and simplicity of changing rams in the new Cameron Type "QRC" (Quick Ram Change) pressure operated blowout preventers.

The film also demonstrates the step-by-step procedure of dismantling a Cameron "Flex-Seal" mud valve in the field, replacing its worn parts and re-assembly, the entire operation requiring only ordinary rig tools and little time.

Several copies of the picture are now in the Cameron library and are available for showing to interested groups.

Hold meeting

The Petroleum Engineering Club of Texas A. & M. College, an affiliated student chapter of the AIME, held its second regular meeting of this school year on October 15.

The club was honored to have A. F. Burgin as guest speaker for the evening. Burgin spoke on "The Activities of an Oil and Gas Lease Broker." During the last 25 years Burgin has been actively associated with this part of the petroleum industry.

An organizational meeting of the club was held September 24. The guest speaker was K. Marshall Fagin, field editor of *The Petroleum Engineer*. Fagin spoke on "The Development of Alaskan Reserves."

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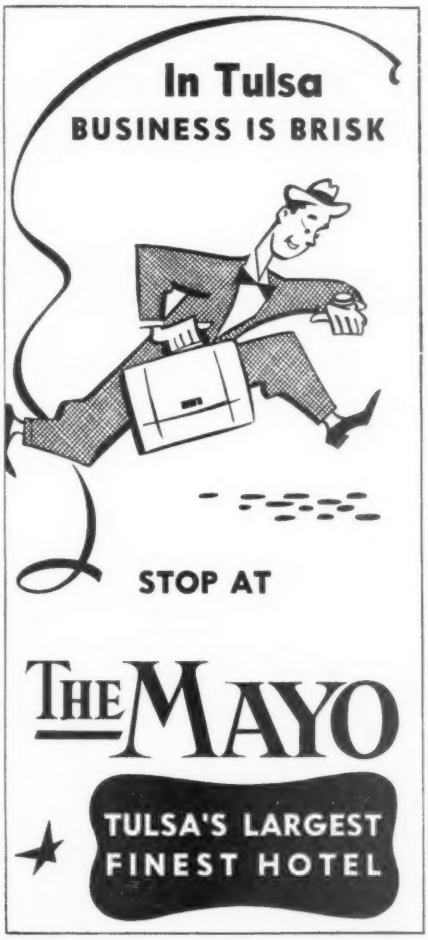

Curtis appointed

Bryan Curtis has recently been appointed district manager at Houston, Texas, for the American Iron and Machine Works Company. Curtis, who was previously field representative working out of the Houston office, has served in many capacities since joining the American Iron in 1936. He formerly represented the company at New Iberia and Harvey, Louisiana, Corpus Christi and Monahans, Texas, and spent two years at the home office in Oklahoma City prior to entering the service in 1942.

Bryan Curtis

J. J. Sloan will succeed Curtis as field representative working out of the Houston office. R. A. Feemster has also been transferred to Houston as city sales representative. Sloan and Feemster previously have been special representatives working out of the Oklahoma City office.

Add service engineers

Oil Base, Inc., Compton, California, manufacturers of Black Magic oil base drilling fluid, has added two service engineers to its staff of field men in the Los Angeles basin area.

Richard R. White, graduate of Texas A & M, was formerly with Pan-American Petroleum Company as production engineer, later serving as reservoir engineer with Core Laboratories, Inc.

Charles L. Piskac graduated from Nebraska University after his discharge from the Army Air Transport. Formerly, he had served with Nebraska State Highway Division and National Supply Company.

Both White and Piskac will have their headquarters in Long Beach, replacing A. E. "Bud" Harris who has been named plant superintendent of the new Oil Base, Inc., plant in Compton. Harris will be in charge of all production and manufacture of Black Magic and allied products. He is one of Oil Base, Inc.'s first field men and is familiar with all phases of oil base muds, their manufacture as well as their ultimate use.

Sales engineer

Link-Belt Company announces that John Yetter has been appointed district sales engineer, ball and roller bearing division, with headquarters at the company's plant in Dallas, Texas.

Yetter is a graduate of Texas A & M, 1942, and went immediately into the Air Corps.

He joined the Link-Belt organization about two years ago and spent most of a year in training at the company's ball and roller bearing division plant in Indianapolis before being transferred to the Southwest.

Jack will specialize on the application of ball and roller bearings to oilfield operating equipment.

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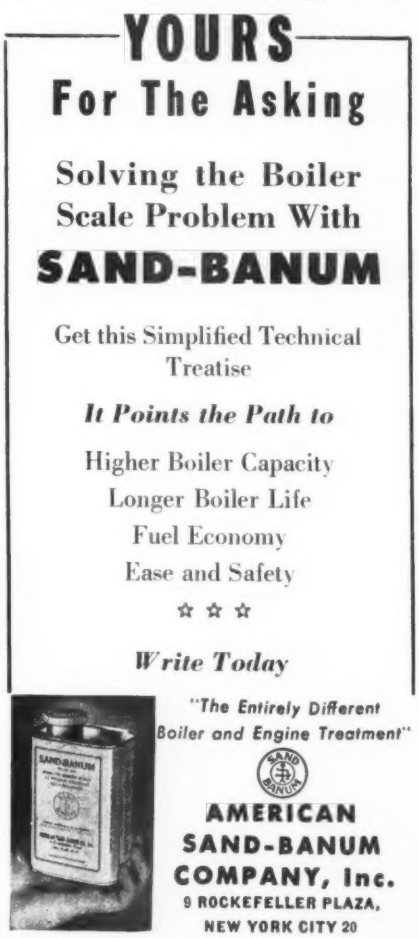


California Natural Gasoline Association holds fall meeting

Front row, left to right: Dan T. McDonald, Magnolia Petroleum Company; Harry Fiske, Ingersoll-Rand Company, New York; G. M. Liljenstein, The California Company, New Orleans; E. O. Bennett, Houston; W. A. Kirk, CNGA vice president; C. R. Williams, president NGAA. Second row: Wm. F. Lowe, secretary NGAA; Harry Peers, Ingersoll-Rand Company; W. S. McAllister, Warren Petroleum Corporation; Ray Miller, duPont Company, Wilmington, Delaware; F. J. Colton, president CNGA. Back Row: E. R. Millett, Jr., CNGA secretary-treasurer; R. S. Ridgway, chairman, fall meeting.

Presenting the first paper on the program of the twenty-second annual fall meeting of the California Natural Gasoline Association, October 10, at the Los Angeles Ambassador Hotel, Marion E. Dice, manager of the economics department of the General Petroleum Corporation, stated that current supply and demand trends for petroleum products indicate that a shortage of some 100,000 bbl a day of liquid fuels will exist in California by the end of 1951. Dice assured his listeners, however, that no shortage would be allowed to develop. "The present liquid fuel industry," he stated, "has long since ceased to be a servant of crude oil, existing only for the utilization of one kind of natural resource. It is rather the servant of the machines that consume the fuels. We shall make the kind of fuels needed for the engines of the future and in the quantity needed without much regard to the source or nature of the raw material." Other raw materials suitable for the manufacture of liquid fuels were stated to be natural gas, coal and oil shale.

Following Dice, papers were presented by Dan T. McDonald, chief process engineer, natural gas department, Magnolia Petroleum Corporation, Dallas; E. J. McLaughlin, supervisor engine fuels division, California Research Corporation, San Francisco; Roy M. Bauer, gas supply supervisor, Southern California Gas Company, Los Angeles; and E. O. Bennett, Petroleum Consultants, Houston. The meeting was one of the most successful in CNGA history with registration in excess of 750, according to F. J. Colton, association president. The meeting was under the chairmanship of Robert S. Ridgway, Standard Oil Company of California. Assisting Ridgway were the house committee, Ed Valby, Richfield Oil Corporation, chairman; the membership committee, Raymond Todd, Pacific Lighting Corporation, chairman; and the entertainment committee, Roland Raasch, OFFCO Company, chairman.

A.I.M.E. meeting

The preliminary program of the All-Texas Meeting of the Petroleum Division of the American Institute of Mining and Metallurgical Engineers, to be held at College Station December 4 and 5, has been announced as follows:

December 4

8:30 a.m.:

Registration and distribution of preprints, Petroleum Engineering Building. Registration fees: Members, $1.00, students, complimentary. Sale of banquet tickets, $1.50.

First technical session

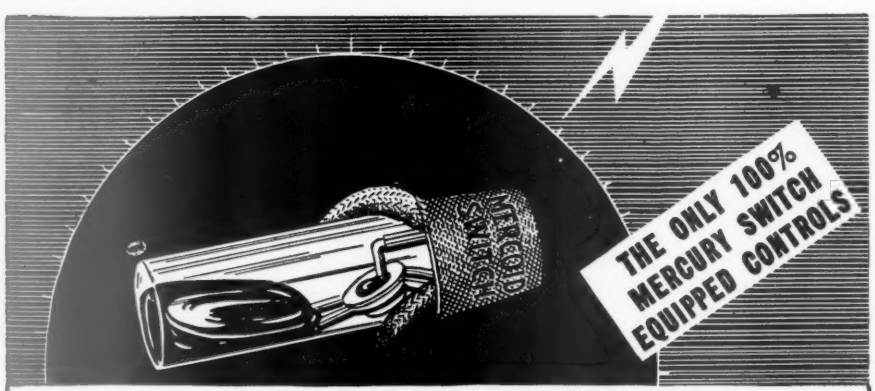
Petroleum Engineering Building, Room 140. Associate chairmen: Harold Vance, A & M College of Texas; I. W. Alcorn, Pure Oil Company, Houston, Texas.

9:30 a.m. to 12:00 noon:

1. Research Facilities at A. & M. College of Texas. H. W. Barlow, Dean of the School of Engineering, A. & M. College of Texas.
2. Progress in Petroleum Production Research. Dr. C. R. Hocott, Humble Oil and Refining Company, Houston, Texas.
3. Optimum Conditions for Condensate Recovery. Burton W. Whiteley, Standard Oil Company (Ohio), Oklahoma City, Oklahoma.

Second technical session

Associate chairmen: H. H. Power, the University of Texas; R. K. Guthrie, U.S.B.M.



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1:30 p.m. to 5:00 p.m.:

4. Diamond Coring and Core Analysis of Fractured Dolomite in the Permian Basin. Burton Atkinson, David Johnson, Humble Oil and Refining Company, Midland, Texas.
5. Cased vs. Open Hole Completions in the West Texas and New Mexico Area. R. M. Rutledge, W. J. Jackson, Lane-Wells Company, Dallas, Texas.
6. Student contest. Cash prize of $50.00 offered by the Gulf Coast Section.

7:00 p.m.—Banquet, Sbisa Hall.

Presiding, A. O. Hamon, president of Petroleum Engineering Club, A & M College of Texas. Toastmaster, Henry Gruy. Awarding of student prize by Gulf Coast Section. Principal speaker, Colonel T. H. Barton, chairman of the board, Lion Oil Company, El Dorado, Arkansas.

Third technical session

Associate chairmen: R. S. Christie, Amerada Petroleum Company, Fort Worth, Texas; W. S. Morris, East Texas Salt Water Disposal Company, Kilgore, Texas.

9 a.m. to 12:00:

7. The Function of Petroleum Engineering Departments and Their Relationship to Management. D. V. Carter, Magnolia Petroleum Company, Dallas, Texas.
8. Preliminary Investigation of Pressure Relations in the East Texas Basin. John Bell, Humble Oil and Refining Company, Tyler, Texas.
9. Energy Relations in the Flow of Gas Through Sands. W. H. Bowie, the University of Texas.

Fourth technical session

Chairman: R. S. Dewey, Humble Oil and Refining Company, Midland, Texas.

1:30 p.m. to 5:00 p.m.:

10. Water Flooding in Texas. R. K. Guthrie, J. W. Amyx, U. S. Bureau of Mines.
11. Vertical Segregation of Zones with Plastics in Oil and Gas Wells. C. E. Mangold, Dowell Incorporated.
12. Gas Lift for Dual Wells. Dan Whittenburg, Garrett Oil Tools Company, Houston, Texas.

The program committee consists of A. B. Stevens, chairman; W. L. Crothers, Permian Basin; E. B. Miller, Jr., Gulf Coast; R. S. Christie, North Texas; P. J. Lehnhard, East Texas; R. J. Bethancourt, Southwest Texas, and H. H. Power, the University of Texas.

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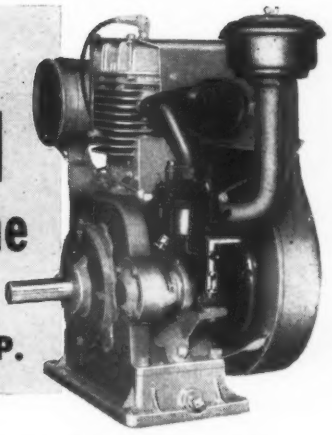

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DICK SNEDDON

Pacific Personalities

There was nothing conventional about the American Association of Oilwell Drilling Contractors convention at Long Beach except the weather. From the beginning to the end, Old Sol smiled benignly on his drilling children, and many a delegate spent his mornings on a beach bench absorbing deeply of the ultra violet and exuding copiously of the *ultra violent* that he had absorbed the night before. The affair was completely non-conventional in some rather remarkable ways. Supply companies, for example, feted other supply companies with a fine generosity that may have been completely accidental but was nonetheless acceptable—and accepted. The hearts of all the Scotch delegates (guess which one especially) were gladdened terrifically by the goodness of the Hughes Tool Company, which institution hosted a daily breakfast in the Skyroom of the Wilton. One of our most horrifying experiences came the morning we slept in and almost missed this attractive event. On the receiving line at various times, it was our privilege to meet such out-of-town celebrities as Max Campbell, Lewis Garfield, Ralph Neuhaus, Furness Prell, Lyle Payne, Floyd Scott, and, of course, such local celebrities as C. J. McLaren, who sure hates to see a man eat a barbecued steak with his hat on—the hat being on the man, not the barbecued steak—and John Isaacs, the personable lad without whom no California oil function is quite complete. Without meaning to cast any asparagus on the rest of this imposing array, we were especially interested to meet Furness Prell, whose reputation as an authority on hard rock drilling has reached all the way from Houston to Glendale, and of whose grand work in the field of human relations we have heard much that is complimentary.

Technically, the three-day session was all that could be desired, thanks to those self-effacing chaps, Tom Pike and Doc Hayes, who had worked like beavers to shape the right kind of program. The facilities of the huge Long Beach municipal auditorium were ideal for such a meeting and the visiting delegates were duly impressed with the immensity of this fine building. Indeed, it is said, one of the Dallas boys, fearful that he might not find his way out again, had to be forcibly restrained from blazing a trail to the concert hall with a rig builder's adze. Socially, the convention was also a pronounced success, due largely to the efforts of Elmer Decker, George McCarthy, and Dick Pettijohn. Deck, who had a capable hand in almost everything that went on, gave an impressive exhibition of versatility at the big closing banquet by handling the microphone with all the finesse and aplomb of a Coleman or a Crosby, in fact, there has been some talk of calling him Bing Decker from now on. George McCarthy, the Hibernian representative on this trio deserves a stout huzza for staging one of the best vaudeville shows we have ever seen at an oil men's gathering, and Dick Pettijohn's feeding of the multitude was a bit of right nice purveying for which he, too, should receive a gold star with several clusters. All the other officers of the California chapter, including Karl Kellogg, Ned Brown, Ralph Marshall, Doug Graham, Gene Reid, Ed Simonis, and their respective committee members have a right to feel pleased over the success of this outstanding event. And, let us not overlook Slim Fowler, the well known fly fisherman, who, up to the moment of his sickness, had carried a formidable load, and carried it over most of the rough places. If, as the psychologists say, wishes and high hopes have a definite restorative value, there is no doubt whatever that Slim will soon be right on the beam again—and that will make us all feel better.

Now going back to the very beginning of things, we personally arrived in the Iowan metropolis on the night before the grand opening of the festivities, placed our toothbrush on the rack at the Robinson Hotel, and wandered over to the Wilton, seeking some friendly soul with whom we might discuss tideland drilling, whipstocking, our appendectomy, or some similarly inspiring topic. The search at first was fruitless and we were just about to go to bed when who should loom up on our starboard bow but By Landis, the Web Wilson impresario, his

ladylove, Cammy, no less, and a good looking scion of the House of Van Loozen, answering like his illustrious Ideco father to the simple name of Van. Naturally, being of low tonnage we were caught up in the wake of this entourage, and in no time at all were tagging along at the end of the procession like a somewhat undernourished caboose. There followed a long and glorious adventure in the course of which we became acquainted with delegates of all sizes, shapes, and sexes. We also confirmed a long held suspicion that this here Cammy is mighty nice people, which gives the Landis twosome a pretty high Crosley rating, since we already had By classified AA.

Anyway, by devious routes we eventually made the Wilton Sky Room, and there tripped the light fantastic toe in a manner that was by all means fantastic. It was here that we adopted a dancing partner by the name of Jack Baroid Beesley, a terpsichorean of no mean order from Tulsa, and together we worked out an adagio routine that would have shamed Veloz and Yolanda, in fact, we were just a tiny bit ashamed ourselves. However, the song eventually ended and there was nothing left but the malady, if you know what we mean. Nevertheless, next morning we sprang out of bed, as spry as a wet newspaper—and would have sprung right back in again if the boss hadn't been at the convention. Incidentally, we might mention that among the interesting folk we met in the Landis suite were Ken Davis, Merle Cribbs, and Frank John of the Mid-Continent Supply Company, Fort Worth; Charley Lewis, Lewis Manufacturing Company, Oklahoma City; Morris Hart, Houston Oilfield Materials Company, Tulsa; E. L. Oliver, manufacturers' representative, Oklahoma City; Bob Block, International Petroleum Company, Peru; Dick Winder and H. J. Hagn, Weco, Houston; Gordon Jackson, Eastman Oil Well Service, Denver; Leo Bell, handling the Contractors' training program at Kilgore Junior College; Chuck Dillinger, Texas Petroleum Company, Caracas; Mutt Donovan, Martin-Decker, Oklahoma City, and George Stevens, Cummins Engine Company, Fort Worth.

We were fortunate in our later gyrations to run into Jack Hays, ex-professor of petroleum engineering at Texas A & M, subsequently senior petroleum engineer for Magnolia, and now officiating in the same capacity for Key Contractors, right here in Los Angeles. Jack is an ardent golfer and plays another game called polo, which is just golf with horses. It was interesting to learn from him that a chukker is a period of play, and not, as we had always thought, a slang name for the pitcher. Regardless of all that, it is our suggestion that Russ Havenstrite sharpen up his mallet and look to his laurels before Jack cuts loose locally. Another imposing delegate from the Lone Star State with whom we exchanged a few friendly sallies was big, easy-to-know John Woodruff who heads up the field educational program under the extension service of the University of Texas at Austin, and from all accounts is handling the assignment with a great deal of credit to himself and a great deal of advantage to the industry. As we understand it, the University offers fundamental study courses in field operations, of such a nature and at such times that men already employed can equip themselves to keep abreast of the most modern technique and development. John has all the attributes both of a counsellor and educator, and if he ever organizes a similar course out here in California, we know one pupil he can count on for certain.

Noted at the technical sessions and keenly interested in the remarks of the speakers was Douglas Pitkeathly, a lad who has made a very nice impression in these parts. He hails from Masjid-I-Suliaman, which for the benefit of any linguists who may be listening in is pronounced Masjid-I-Suliaman. "Pit", as we came to know him here, is assistant drilling superintendent for the Anglo-Iranian Oil Company, Ltd., and he missed no opportunity during his stay to look into our ways and means of reaching the oil sands. As a result, we imagine, he has gathered a lot of useful information the which to study more leisurely when he gets back on the job. Socially, he fitted into all the local goings-on like a native and he made many friends during his stay. His plan was to return to his stint via the main office in London, England, and we are all hoping that it won't be too long until he finds it necessary to take another trip to the U. S.

Actually, there was so much going on in this big three-ring circus that it would be impossible to recite it all here. It would be criminal, however, not to mention the Mission Manufacturing Company party, which was really an epicure's dream. It surpassed everything of the kind we have experienced—and, believe us, we are no stick at home. The food was more than

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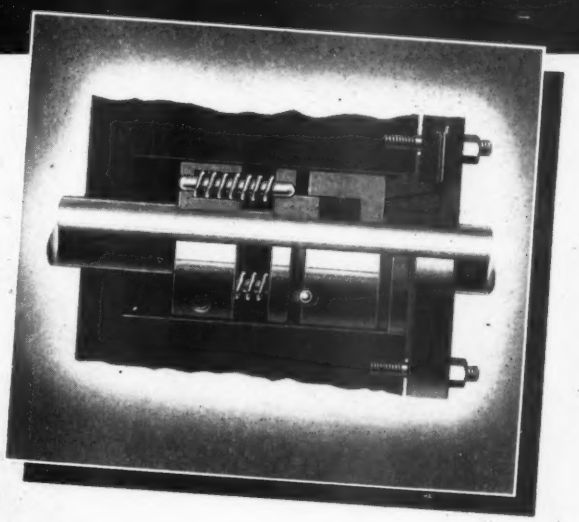

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good, it was positively exciting, and we never came nearer to disgracing ourself gastronomically. So busy did we keep the Chef with the French accent who was dishing out a hot crab, lobster and shrimp delicacy he called a "boolabong", or words to that effect, that the other guests began to mutter darkly in their beards, and we moved along—but definitely under protest. We met everybody of consequence in the oil business at this soiree, but greeted particularly among our hosts, "Tee" Campbell, Dudley Sharp, and Lonnie Roberson.

Bill Heater, the Baroid baron, and his cohorts entertained in a convenient hideout in the Villa Riviera, where the new guests came in the front way, heard a few limericks, and were ushered out the back. In this maneuver he was ably assisted by Fred Christanelli, the public relationist from Houston who is the industry's top concertinist. In the same building, Lee Laird, Joe Schlarb, and Frank Weigand hosted for Chiksan and generally rustled around as if they were all equipped with swivel joints. In the Wilton, we found Ox Morgan, Bill Brooks, Jack Ballagh, Garth Nicolson, and other B-J luminaries holding up very well despite a terrific mass attack by a battalion of Texans and Oklahomans. From all quarters we were besieged—Fred Carlisle of International Cementers over at the Robinson, Ernie Pyles of Jergins, in the Jergins Trust Building, and so on ad infinitum. But life is short and there are pinafores to be washed, so, much as we love good company, we simply couldn't make them all.

Random Notes: With respect to the new prexy, Ned Brown, we would just like to say it couldn't happen to a nicer guy, and we venture to remark further that he is following a top citizen. We just instinctively liked Ed Warren—he gives the impression of energy-plus, coupled with lots of good sense, which is all that anybody needs to run an institution successfully. In passing, Reese Taylor's windup speech was a dilly—delivered with punch and loaded with the stuff of which at the moment we can't disseminate too much. It had exactly the right flavor for a grand finale. Watched Reese and Sam Grinsfelder walk out together after the show, and Sam, although a pretty good sized mortal, looked like a small boy alongside of his chief. Tommy Thompson makes his headquarters in Houston but does most of his work in West Texas. He probably used the first string of Hydril drill pipe ever used in an oil well, and is one of the real pioneer drilling contractors. Has a boy who loves golf and plays it well—but only when his school grades are right. Pop says, "No grades, no golf!" Liked Joe Zeppa's handling of the microphone in the concert hall—has clear, careful diction—easy to listen to. He is the peer of oilwell drilling contractors in the Great Piney Woods of East Texas. Bill Payne, former president of the Big Chief Drilling Company, Oklahoma City, loves hunting. Every time business slacks off, he goes hunting—new business. Brad Mills used to be a news press feature writer—does all right as an executive vice president, too. George Livermore, independent operator and drilling contractor in parts of West Texas and all of New Mexico, took to the business because there is nothing he likes better than a fishing job—somewhere in the vicinity of his ranch. Stan Williams, vice president of Thomas P. Pike Drilling Company, holds the Los Angeles Athletic Club squash doubles championship along with Joe Powers, and that, friends, is no game for a sissy. Wherewith we conclude—totally and completely the AAODC convention was such a success that we don't have half enough room to tell you about it, but we'll be back.

Cameron employes hold annual picnic

Cameron Iron Works, Houston, Texas, was host to its employes and their families at a barbecue on October 12. Approximately 1500 persons attended the party, which was held on a beautiful wooded site at the company's manufacturing plant near Houston.

Attendance prizes, including a washing machine, radio, bicycles, and electrical appliances, were given and music and other entertainment were provided throughout the afternoon.

A highlight of the barbecue, which has become an annual affair, was a sightseeing tour through the shops and the new Cameron forge plant for members of the employes' families to acquaint them with the numerous items of drilling and completion control equipment and specialties manufactured by their company.

Meserve heads Fluor Corp.

The Fluor Corporation, Ltd., Los Angeles, has announced its new managerial organization following a special meeting of the board of directors, which was necessitated by the recent untimely death of the company's president and chairman of the board, Peter E. Fluor.

S. E. Meserve

Shirley E. Meserve, vice president and general counsel, was elected president. Meserve, an outstanding man in the legal field ever since his admission to the practice of law in 1912, has supervised Fluor's legal affairs since 1926, being made a director of the corporation in 1937. He is also a senior member of the law firm of Meserve, Mumper and Hughes, Los Angeles.

W. Earl Dunn, vice president and general manager, will now serve as executive vice president; D. W. Darnell, vice president and chief engineer, was promoted to vice president and general manager; and J. Robert Fluor, manager of manufacturing, was named vice president and assistant general manager. James P. Wiseman, director of sales, and T. H. Seavey, manager of purchases, both were made vice presidents. Francis E. Fischer continues as secretary-treasurer.

Robert L. Merrick, assistant chief engineer, was elevated to chief engineer, and Foster M. Stephens, director of development, was advanced to assistant manager of manufacturing.

Fluor's board of directors consists of Meserve, Dunn, Darnell, J. R. Fluor, Wiseman, Seavey, Fischer, and Fred C. Fluor.

Lincoln Foundation awards

The trustees of The James F. Lincoln Arc Welding Foundation, Cleveland, have announced the awards in its $200,000 Design-for-Progress Program. The 467 awards range from $100 for honorable mention to $13,200 for the main award.

The first main award of $13,200 was divided among Paul F. Hackethal, chief engineer, Clarence C. Mast, shop superintendent, and Douglas W. Hamilton, welding foreman, all of the Koppers Company, Aeromatic Propeller Department, Baltimore, Maryland, for their co-authorship of a paper entered in the Aircraft Classification.

The second main award of $10,700 was awarded to Kiser E. Dumbauld, design engineer, of the Bureau of Bridges of the Ohio State Highway Department, for his paper in the Structural Building and Bridges Classification.

The third main award of $8200 went to G. J. Storatz, engineer in charge, the Heil Company, Milwaukee, Wisconsin.

The many papers entered in the 15 different scientific and engineering classifications of the Program were submitted from every section of the United States. They covered every field of design in manufacturing, research and maintenance through electric arc welding. Participants included scientists, engineers, production and supervisory personnel, maintenance and methods engineers from both private and large industrial operations.

The significance to industry of the savings that are to be achieved through the application of the arc process as indicated in these papers gains added emphasis from the current upward trend of manufacturing costs and prices. In a similar Award Program held in 1942, the Jury of Award stated "the savings to industry by arc welding claimed by the authors of papers aggregates $1,600,000,000. This figure is arrived at after discounting some very enthusiastic claims." With the added knowledge of the process gained through its wide-spread use during the war, and with the accelerated manufacturing operations, it is safe to say that such savings as outlined by the papers in the 1947 Program would aggregate over $2,000,000,000, according to the secretary.

The secretary further states that The James F. Lincoln Arc Welding Foundation seeks to bring out the inherent ingenuity of the men who create American industry, which is the spark of our system of competition and free enterprise. The imaginative use of this ingenuity constantly perfects better techniques and better coordination of production with a resultant higher standard of living.

To achieve this, the Foundation sponsors the preparation and writing of papers on arc welded design, research and education. Through both published books and technical articles abstracted

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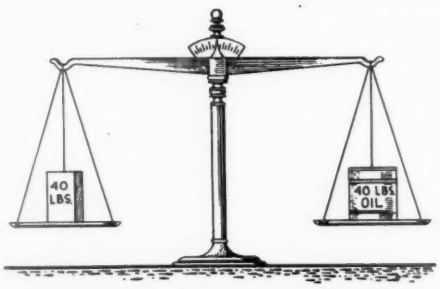

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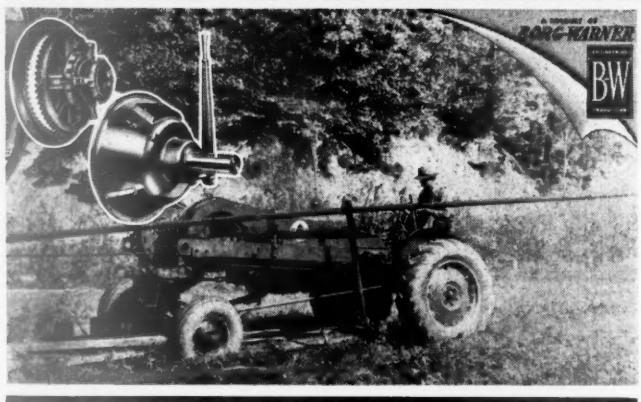

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* The housing supports the drive shaft, which is mounted on a main bearing in the housing and a pilot bearing in the engine flywheel. The heavy-duty clutch is mounted on the drive shaft, which is extended to serve as an output shaft for the external drive, and may carry a pulley, gear, sprocket, or drive through a coupling.

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from the papers, the information thus accumulated is made available to all men in the engineering and educational fields.

The Lincoln Foundation was created in 1936. Its purpose, as stated in the deed of trust, "is to encourage and stimulate scientific interest in, and scientific study, research and education in respect of, the development of arc welding."

The 1946-47 Award Program is the third in a series of similar programs and is only one of the educational activities of the Foundation. It conducts an Annual Undergraduate Award and Scholarship Program in engineering schools. It has also provided funds to 250 engineering schools in the United States and other countries for the purchase of scientific books on welded design and applications. These libraries are maintained with contributions of the latest material on this subject as it is published. The Foundation publishes a number of books. One now in the course of publication is called "Welding Helps for Farmers", which is expected to add greatly to the economic life of the agricultural field; also several textbooks containing the latest information on modern machine and structural design are in progress.

As a result of the present Program, the Foundation expects to publish a number of additional books, the chief one of which will be called "Design for Welding", which will be available early in 1948.

Axelson changes in top personnel

Announcement has been made by J. C. Axelson, president and general manager of Axelson Manufacturing Company, of the retirement and resignation from that firm of D. F. Axelson, formerly vice president in charge of manufacturing, effective September 21.

Widely known throughout both the machine tool and petroleum equipment industries, D. F. Axelson's retirement marks the close of some 40 years' association with the company, founded in 1892 by his father and uncle.

Axelson's retirement has resulted in the promotion of R. M. "Bob" Pease, formerly vice president and assistant general

D. F. Axelson

Victor Mancuso

R. M. Pease

manager. This promotion became effective October 6, and Pease is now making his headquarters at the main plant in Los Angeles.

Also promoted in the Axelson organization is Victor "Vic" Mancuso, formerly works manager, to the position of vice president in charge of manufacturing.

Pease first joined the Axelson organization in 1917; Mancuso has an uninterrupted service record with the company since 1919.

Baker employe service awards

With Ted Sutter, executive vice president, officiating as master of ceremonies, employes of Baker Oil Tools, Inc., gathered at the Rio Hondo Club, Downey, California, October 18, where awards for service were made by the founder of the company, R. C. Baker, Sr. Starting out as the Baker Casing Shoe Company in 1913, with headquarters in Coalinga, the first notable expansion was the purchase of a machine shop there, which, incidentally, has operated continuously from that time to the present. The real growth of this now substantial organization, however, came between 1920 and 1924, when rotary drilling began to take hold in California, and the Baker company developed and manufactured many new equipment items essential to the rotary process.

In 1922 the main office was moved to Los Angeles and the business of reaching out to all the oil producing states was begun. It was at this time that Ted Sutter joined the staff in the

capacity of office manager. Ted was born in Chicago, educated in Butte, Montana, and had had an interesting experience, or series of experiences, during the first ten years of his working career. Variegated responsibilities, including assignments with International Harvester in industrial relations, and with Stone and Webster in similar work, had early awakened his interest in the employe problem, and has stood him in good stead since.

When he first took over at Baker Oil Tools, Inc., the organization boasted 12 employes—now it has 500, and Ted Sutter has not merely watched it grow to these dimensions, but has played a highly important part in making it grow. He personally opened the Tulsa, Oklahoma, and Houston, Texas, agencies; traveled to Venezuela and Europe in the interest of further expansion, and as executive vice president has kept his finger on the pulse of the industry through every economic change. For the last 25 years he has exercised his wide capabilities in the general field of administration, directing the sale and distribution of all company products so successfully that they are now known in virtually every oil producing country of the world. For all of this he was paid high tribute by President Baker as he awarded his 25-year pin.

Another recipient of the 25-year pin was George M. Anderson, sales manager in charge of the Pacific area. George was born in Scotland, but left there at the age of nine to try his luck in the United States. He became a member of the Baker staff as a machinist at Huntington Park in 1922, after a stretch in France with the Canadian army during the first world war. He was elevated to the position of sales representative in 1923 and four years later was moved to Tulsa, Oklahoma, as representative in that area. Returning to California, he was given the San Joaquin Valley territory, with headquarters in Taft, where he remained until 1929, at which time he was appointed California sales manager. Hobbywise, George likes to sing, and does so more than usually well. He is frequently heard as soloist at oil people's functions, and is a chanter for the Shrine.

Of interest also to men of the industry is the award of a 20-year pin to Claire E. Whitney, assistant general manager in charge of Mid-Continent and Gulf Coast areas, with headquar-

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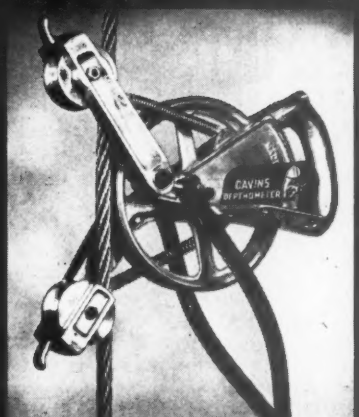

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ters in Houston, Texas. Whitney is one of the pioneers of rotary drilling, which very well explains his connection with the Baker concern. He had made his home in Coalinga for 20 years before signing up with the Baker company in Taft in 1927. He was associated with Percy Pike in Federal Drilling Company and was one of the first real authorities on the rotary system. In fact, he was probably the first person to educate California cable drillers in rotary technique. Following the Taft assignment with Baker Oil Tools, he was transferred to Los Angeles as general sales manager, and in 1936 took over the Houston office and its contingent territories when the company built its manufacturing plant. He recently came west with a planeload of drilling contractors bound for the convention at Long Beach, and stayed over to receive his pin from R. C. Baker, Sr., while 250 guest employes vociferously indicated their approval.

To study off-shore drilling

International Derrick and Equipment Company have engaged Charles F. Cisler of Marietta, Ohio, to make a special study and research of off-shore drilling operations. Particular attention is now being directed toward the proper application of sea floor foundations and involved engineering problems.

C. F. Cisler

Cisler was born November 16, 1903, at Marietta, Ohio, where, while completing his public school education, he entered into general construction work with the family firm. He soon became a junior partner in the firm. Cisler did college undergraduate work at West Virginia University and at Marietta College where he graduated with the class of 1926. His post-graduate work at Columbia University was completed by 1928.

Previous to World War II Mr. Cisler's construction firm was engaged in railroad, street, and highway work, as well as river dredging, lock, and dock construction on the inland waters of the mid-eastern states. During the recent war, he offered his services to the U. S. Army, Corps of Engineers, and was assigned to General MacArthur's staff in the chief engineer's office.

Colonel Cisler represented this office as inspector of all construction and engineer units under General MacArthur's command.

Cisler will spend time in the Gulf Coast area, observing offshore operations and discussing phases of the problem with engineers associated with the work.

Drilling fluids conference

Bulletin 96, entitled "Drilling Fluids Conference", has been issued by the Engineering Experiment Station of A. and M. College of Texas, College Station. This bulletin contains the papers and discussions given at a drilling fluids conference held May 13-15, 1946, under the auspices of the Petroleum Engineering Department.

Individual copies of this bulletin will be mailed free to anyone desiring a copy, Harold Vance, head of the Department of Petroleum Engineering, states. Address: Engineering Experiment Station, A. and M. College, College Station, Texas. Multiple copies, however, are priced at 25 cents each, Mr. Vance says.

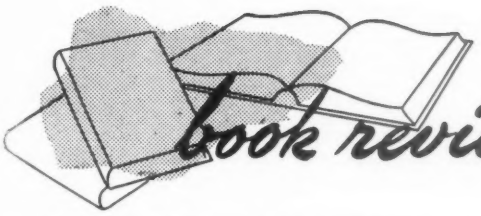
Living-cost bonus for Houdry employes

Houdry Process Corporation will pay a third cost-of-living bonus to employes of the corporation and its subsidiary, Houdry Process Corporation of Pennsylvania, Arthur V. Danner, executive vice president and chief executive officer of the company, has announced. The bonus will be equivalent to 16 per cent of the basic compensation for the four-month period September 1 to December 31, 1947, inclusive. The bonus is payable during the week ending November 28.

Appoints sales engineer

Angelo D. Scotty, Jr., has been appointed sales engineer for the Vapor Recovery Systems Company in Houston, Texas. He will assist John L. Shaunty, Houston district manager.

Scotty is a Houston boy and a graduate of Rice Institute, where he obtained a degree of B.S. Ch.E. During the war he was a navigator in the U. S. Army Air Corps.



● **American Oil Operations Abroad,** *by Leonard M. Fanning. Published by McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, New York. Pages, 270. Price, $5.*

Importance and magnitude of the foreign oil operations of American oil companies is described comprehensively in a new book "American Oil Operations Abroad," by Leonard M. Fanning, author also of "Our Oil Resources." This book should do much to clear up any misunderstandings as to the facts. It is a comprehensive, factual history of all important American oil operations abroad from their beginnings early in this century right up to the present, when Middle East oil—and all foreign oil—are taking on added importance.

Particularly revealing are the facts about the large risks and investments, and the long periods of arduous work needed to find and develop foreign oil fields. Equally interesting are the accounts of the political background of foreign oil developments. In all foreign countries, American oil interests have the enormous total investment of nearly two and a half billion dollars. The book traces the fascinating diplomatic and operational history behind these huge investments.

Most of the factual data are based on the report presented to the Special Senate Committee. The book should be worthwhile background reading, and a valuable reference source for some time to come as foreign oil continues in the news.

● **Review of Petroleum Geology in 1946,** *by F. M. Van Tuyl, W. S. Levings, and others, Vol. 42, No. 3. Department of Publications, Colorado School of Mines, Golden, Colorado. Price, $2.50. Pages, 316.*

Geologists, geophysicists, and petroleum engineers of many countries contributed to this fifth annual review, in cooperation with the AAPG, to bring forth a broad authoritative treatment of the various phases and wide fields of petroleum geology. Covered are advances in petroleum geology and contributory fields, training and progress in geophysics, geochemistry and petroleum engineering. Progress in world exploration and development gives a global picture of oil and its possible future. Trends in petroleum geology and geophysics; new and improved techniques show that the art of geology is steadily improving while widening its range of activities.

● **Oil Recovery from Wurttemberg Shale,** *by R. H. Smith and others. Hobart Publishing Company, Box 4127 Chevy Chase Branch, Washington 15, D. C., with permission of Office of Technical Services. Pages, 38. Price, $3.*

The construction, operating conditions, processes, and production of German shale oil plants are described in this mimeograph book. The work comprises the detailed report of a technical team headed by Lieutenant Colonel Smith, a Canadian; Major H. Bardgett, British Ministry of Fuel and Power; Dr. W. W. Odell and Dr. L. L. Newman, U. S. Bureau of Mines, and Dr. E. L. Baldeschwieler, PAW.

Some of the plants were on an experimental basis but all of them made interesting developments in extracting oil from shale, some checking up marked improvements in processing. This report is an important addition to shale-oil literature.

● **Chemical and Technical Basis for the Synthesis of Butadiene,** *by Dr. Georg Niemann. Hobart Publishing Company, Box 4127 Chevy Chase Branch, Washington 15, D. C., with permission of Office of Technical Services. Pages, 23. Price, $2.*

One of the reports by technical men on German scientific data, the small mimeograph book contains a lecture comparing two butadiene processes on acetylene: They are via acetaldehyde by addition of water and via butynediol from reaction with formaldehyde.

Flow sheets of the latter process (discovered by Dr. J. W. Reppe) are included. Mention is made of numerous products that can be made from the main process intermediates and certain side products.

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